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GEOGRAPHICAL REVIEW

PUBLISHED BY

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JANUARY
1929

OUR CONTRIBUTORS

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Mr. Hoover is head of the Department of Geography of the Tempe State Teachers College and Associate in Research at the Arizona Museum.

Mr. Rudolph is a civil engineer formerly associated with the Chile Exploration Company at Chuquicamata. He has carried out extensive explorations in Chile and Bolivia. To the October, 1927, *Geographical Review* he contributed "The Rio Loa of Northern Chile."

Mr. Jenness is chief of the Division of Anthropology in the National Museum of Canada at Ottawa. He was ethnologist of the Southern Party of the Canadian Arctic Expedition of 1913–1916, when he carried out important studies on the Copper Eskimos. Several articles dealing with his results have appeared in the *Geographical Review*. Mr. Jenness has also carried out ethnological research in the southern Pacific and is joint author of "The Northern D'Entrecasteaux" (1921).

Professor McAdie is director of the Blue Hill Observatory and professor of meteorology at Harvard University. He has specialized in aerography, the science of the structure of the atmosphere. His numerous writings on meteorological subjects include several papers in the *Geographical Review*.

Mr. Wolfanger, instructor in Economic and Soil Geography at Columbia University, was for ten years associated with the staff of the U. S. Bureau of Chemistry and Soils. His field of investigation includes type studies of most of the major soil groups of the United States, and he now has under preparation a simplified soil map of the United States. To the October, 1926, number of *Economic Geography* he contributed "Economic Regions of Alaska."

Dr. Wigmore is dean of the faculty of law in Northwestern University. He has written extensively on a wide range of aspects of the law in various lands. He has just published a three-volume work "A Panorama of the World's Legal Systems" (1928), which gives a comprehensive picture of the historical evolution of the world's law from the ancient Egyptian legal system down to the present day.

Dr. Pettersson, the distinguished student of physical oceanography, began his scientific career in physical chemistry at the University of Upsala, whence he was called to Stockholm. He was elected General Secretary of the Conference in Stockholm, 1899, at which the International Council for the Study of the Sea was founded: and to him is largely due credit for its organization. He has served as vice-president and president of that Council and himself has contributed largely to its valuable work. The greater number of Dr. Pettersson's later publications concern the dynamics of the ocean and the technical aspects of hydrography.

Major Isachsen is one of the directors of the Geographical Society of Norway and the director of the Maritime Museum at Oslo. He has spent many years in the Arctic: as topographer on Captain Sverdrup's *Fram* expedition 1898–1902 to the Northern Arctic Archipelago; 1906–1910 and 1920–1921 in Spitsbergen; 1922 in Iceland and the Faeroes; 1923 and 1924 in Eastern Greenland. For many years he collaborated with Prince Albert of Monaco in his oceanographical research. He has made an intensive study of the whaling industry. In 1926 and 1927 he accompanied the first expedition for pelagic whaling in the Southern Ocean and Ross Sea.

Professor Johnson is professor of physiography in Columbia University. In addition to numerous physiographic papers he has written "Shore Processes and Shoreline Development" (1919) and "The New England-Acadian Shoreline" (1925). He has made a special study of the influence of physiography in the conduct of military operations. His "Battlefields of the World War" (1921) is No. 3 of the American Geographical Society's Research Series.

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Map of the Antarctic, 1:4,000,000, in four sheets, each measuring 32 by 32 inches, Printed in two colors. Shows known elevations of the land, including Scott and Amundsen lines of march to the South Pole, and ocean soundings and relief by contours; lines of equal magnetic variation; wind roses. The map is accompanied by a **Navigational Chart of the Antarctic, 1:12,000,000,** on a sheet 20 by 20 inches, and a descriptive pamphlet. $10.00.

The Leardo Map of the World of 1452 or 1453. Colored reproduction (measuring 28⅝ x 23½ inches, printed on sheet 35 x 30 inches) of map in the collections of the American Geographical Society. Accompanied by volume containing text by John Kirtland Wright describing the original map and a note by A. B. Hoen on the method of reproduction, with 3 photographs and 7 maps, viii and 90 pp. *Library Series No. 4.* 1927. $15.00 ($2.00 for text alone).

Separate Maps published in the *Geographical Review* and the *Bulletin of the American Geographical Society*, the majority in color. 25 cents each. A list will be sent upon request.

THE
GEOGRAPHICAL REVIEW

VOL. XIX JANUARY, 1929 NO. 1

THE 1927–1928 PERUVIAN EXPEDITION OF THE AMERICAN GEOGRAPHICAL SOCIETY

O. M. Miller
American Geographical Society's School of Surveying

[With separate map, Pl. I, facing p. 32]

THE 1927–1928 Peruvian Expedition of the American Geographical Society was undertaken in conjunction with the program of geographical studies on which the Society's Department of Hispanic American Research is now engaged.[1] A cartographic base is a necessary preliminary; and for the past eight years the Society has been assembling, from all possible sources, surveys and other materials for the compilation of this map. There still are, however, areas in which no surveys have been made or in which such surveys as have been made are not well located with respect to one another. One of the most important of these areas lies west and north of Cerro de Pasco. It extends from the main crest of the Cordillera of the Andes to the Pachitea River. It includes that section of the main cordillera which constitutes the watershed between the Pacific Ocean and three great tributaries of the Amazon which have their headwaters in the region—within a space of 20 miles—the Marañon, the Huallaga, and the Mantaro. A large section of the region is well populated; its western border is known to be highly mineralized; its eastern border recommends itself for future colonization because of its rich soil and equable climate. Most of the region was found to be unknown cartographically except for rough sketch maps and a few river traverses which had not been accurately located by triangulation or by astronomical observations.

The area was so large and so important that it was impossible satisfactorily to compile the Cerro de Pasco sheet until better maps

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[1] R. R. Platt: The Millionth Map of Hispanic America, *Geogr. Rev.*, Vol. 17, 1927, pp. 301–308.

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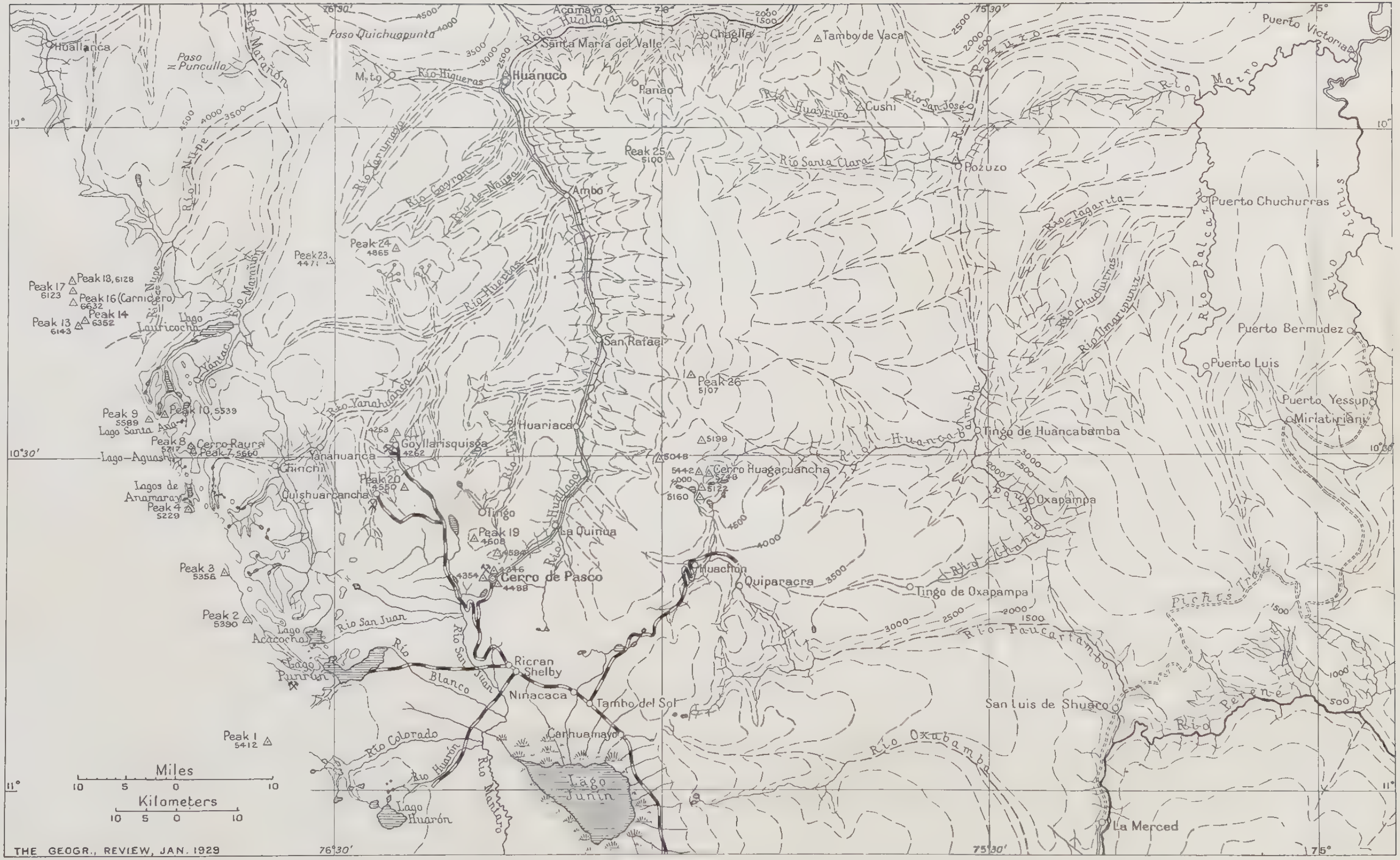

FIG. 1—Map showing the location of the region in Central Peru covered by the Expedition. Scale approximately 1:1,250,000.

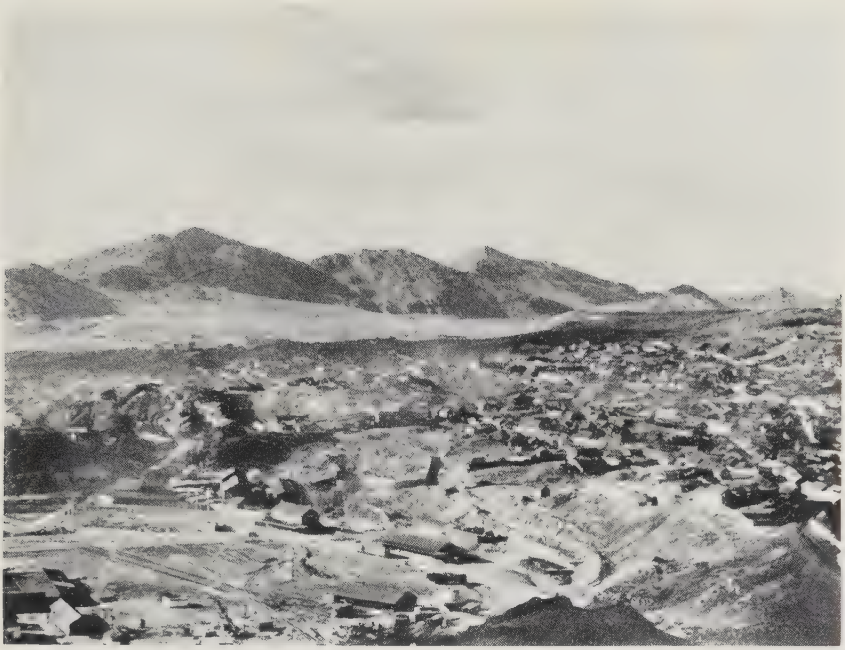

FIG. 2

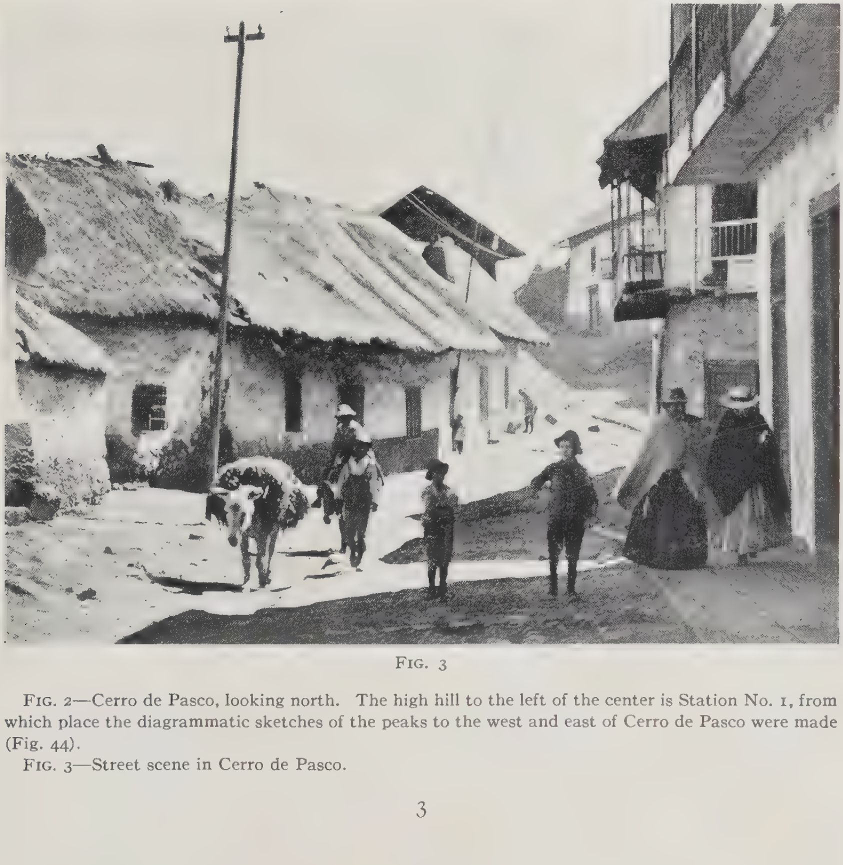

FIG. 3

FIG. 2—Cerro de Pasco, looking north. The high hill to the left of the center is Station No. 1, from which place the diagrammatic sketches of the peaks to the west and east of Cerro de Pasco were made (Fig. 44).

FIG. 3—Street scene in Cerro de Pasco.

became available. The Society, therefore, decided to send a party, consisting of the writer as leader and Mr. Kaspar M. Hodgson as assistant, into the field to conduct surveys and make a study of the geographical features. The Peruvian government showed great interest in the expedition and placed every facility at its disposal. The party was lent government mules and provided with a military escort under the capable command of Captain Benjamin Chiurliza.

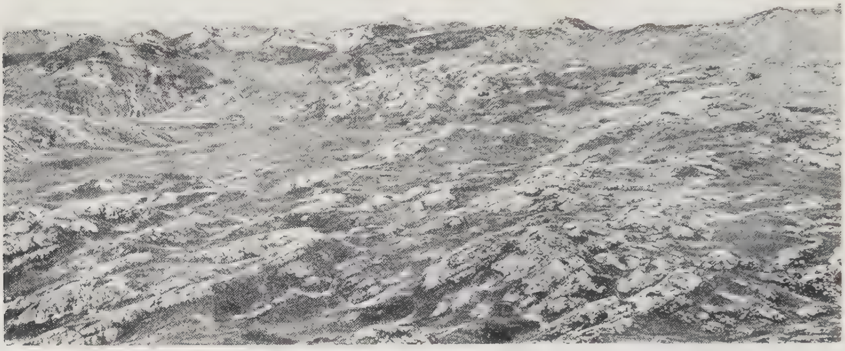

FIG. 4—Looking southeast from Station 1, Cerro de Pasco. This is near the divide between the more level country to the south and the more deeply dissected country to the north. Compare Figure 5.

WORK AT CERRO DE PASCO

The first objective of the expedition was the establishment of a large number of geographical positions by astronomical or trigonometrical methods which could be used as a framework on which to fit local surveys. Headquarters were taken up at Cerro de Pasco, that old town whose fame in South American mining annals is rivaled only by Potosí. We arrived on July 11, 1927, and were kindly accommodated at the hotel of the Cerro de Pasco Company, where we stayed three weeks. The Company's officials were most obliging and helped us in many ways. We used their triangulation stations and thus were spared the necessity of measuring a base. The triangulation was extended to points sufficiently far apart to enable good intersections to be made of the principal points visible to west and east.

The Cerro de Pasco region has been given great importance in classic descriptions of the Peruvian Andes as a mountain knot tying together three distinct cordilleras. Actually the "Nudo" is merely an erosion remnant of the Andean plateau. It constitutes the divide between the Huallaga River system to the north and the Mantaro to the south. The surface of the plateau, which here has a maximum width of 40 miles, is studded with shallow lakes and marshlands. There is, however, a marked difference in relief between the northern and southern slopes of the watershed; the streams of the former have cut deep gorges into the surface, whereas those of the latter meander in shallow valleys. As the Peruvians say, the relief is respectively "quebrado" and "llano."[2] On the west is the main cordillera of the Andes, which here constitutes the Atlantic-Pacific divide. It consists of a series of ridges in echelon to which the general name of Cordillera de Huayhuash has been given. From Cerro de Pasco can be seen two groups of high mountains in this cordillera, the first to the west culminating in the Raura peak, which we found to be 34 miles distant and 18,755 feet high. The second group is over 50 miles away and more to the northwest. It is also much higher, including five or six peaks more than 20,000 feet above sea level. The highest is Carnicero, 21,760 feet, among Peruvian peaks second in elevation only to Huascaran (22,182 feet) in the Cordillera Blanca, which succeeds the Cordillera de Huayhuash northward.

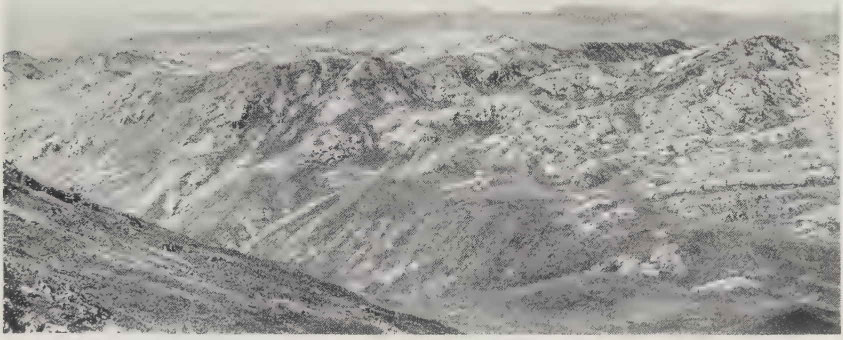

FIG. 5—Looking northeast from Station 1, Cerro de Pasco. Compare Figure 4.

On the east the plateau is flanked by bare undulating foothills rising to the eastern range, whose peaks do not exceed 18,000 feet except in the case of the snow-clad Huaguarancha, 18,797 feet. We saw a number of whitened peaks farther north, but whether they have snow on them all year round is not known. At any rate the mountains get lower as the range proceeds north, and there is no definite continuation between this range and that which forms the divide between the Marañon River and the Huallaga. The true continuation of this eastern range appears to be that which lies to the east of the Huallaga River where the latter turns from flowing east to north. Here it forms the divide between the Huallaga and the Ucayali River systems. Later on in the season we crossed the range at this point and found the highest peaks to be not over 13,000 feet and wooded

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[2] Enrique I. Dueñas: Reconocimiento geológico-minero de la cuenca carbonera setentrional Lima-Junín (Hoyas de Oyon, Checras y Pasco), *Bol. Cuerpo de Ingenieros de Minas del Perú No. 97*, Lima, 1919.

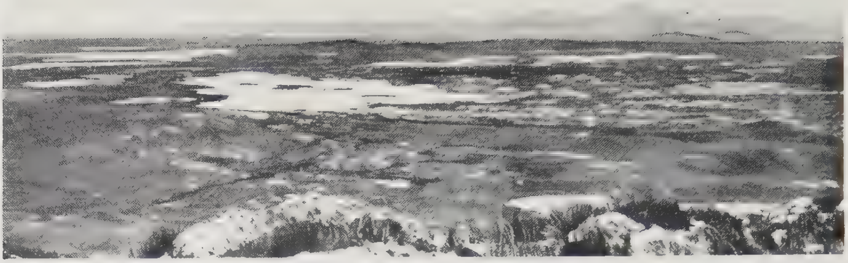

Fig. 6

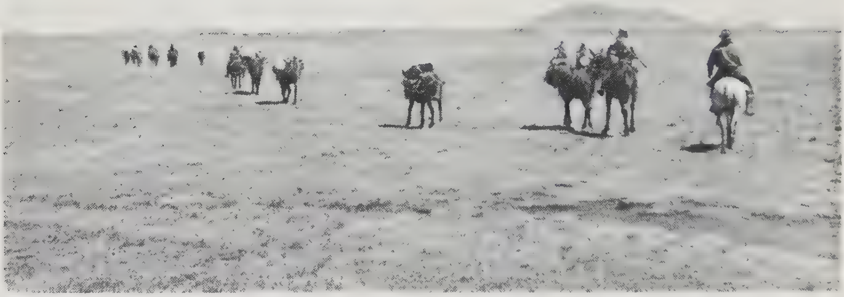

Fig. 7

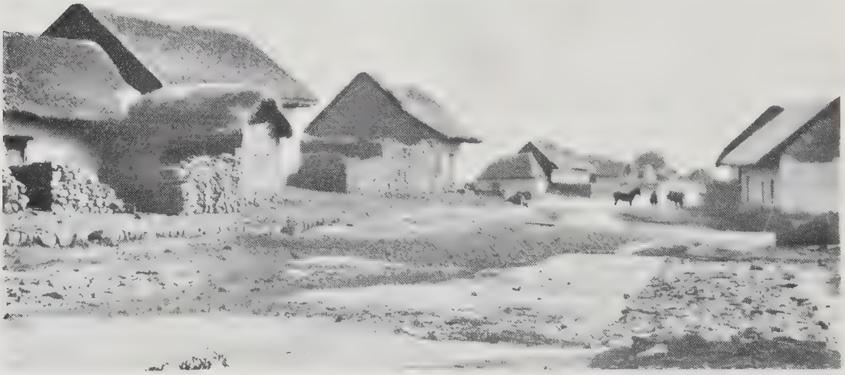

Fig. 8

Fig. 6—Looking east across the flat Nudo de Cerro de Pasco from an isolated limestone ridge to the east of Lake Tucapa. The eastern range in the background.

Fig. 7—Looking across the flat Andean plateau here between 4300 and 4400 meters high.

Fig. 8—Raco, a village on the flat plateau.

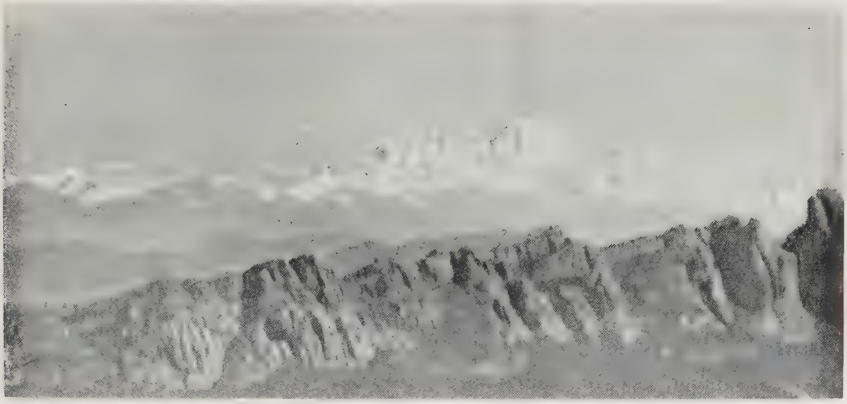

FIG. 9

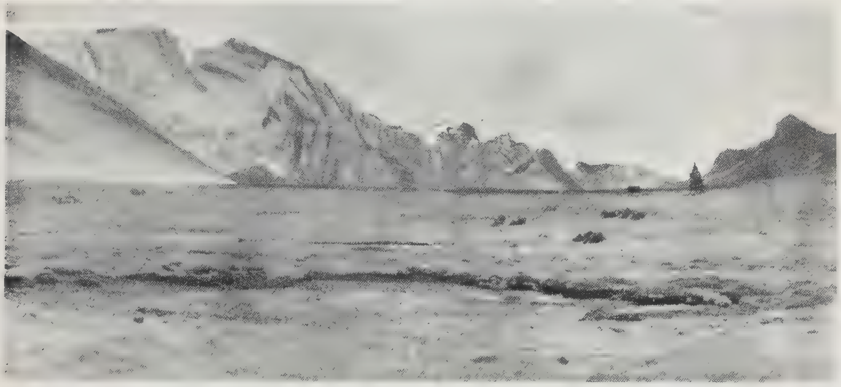

FIG. 10

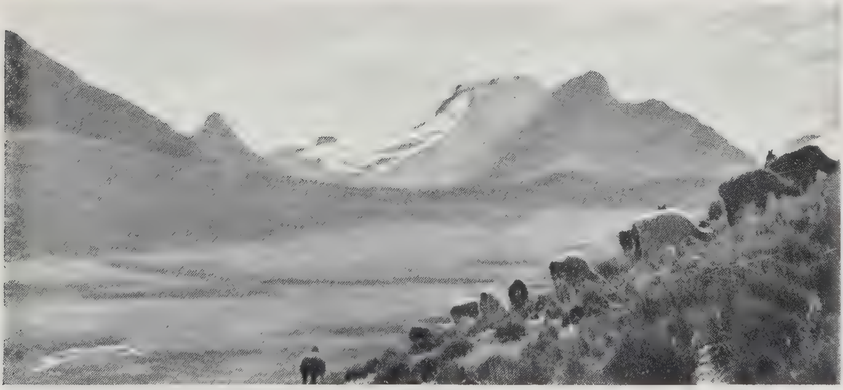

FIG. 11

FIG. 9—Carnicero seen from Station No. 1, Cerro de Pasco. Compare Figure 44.
FIG. 10—The flat upper pampa to the north of the Colpa Grande (4600 meters) looking north.
FIG. 11—Looking northwards towards Lake Acacocha which lies under the mountains in the background.

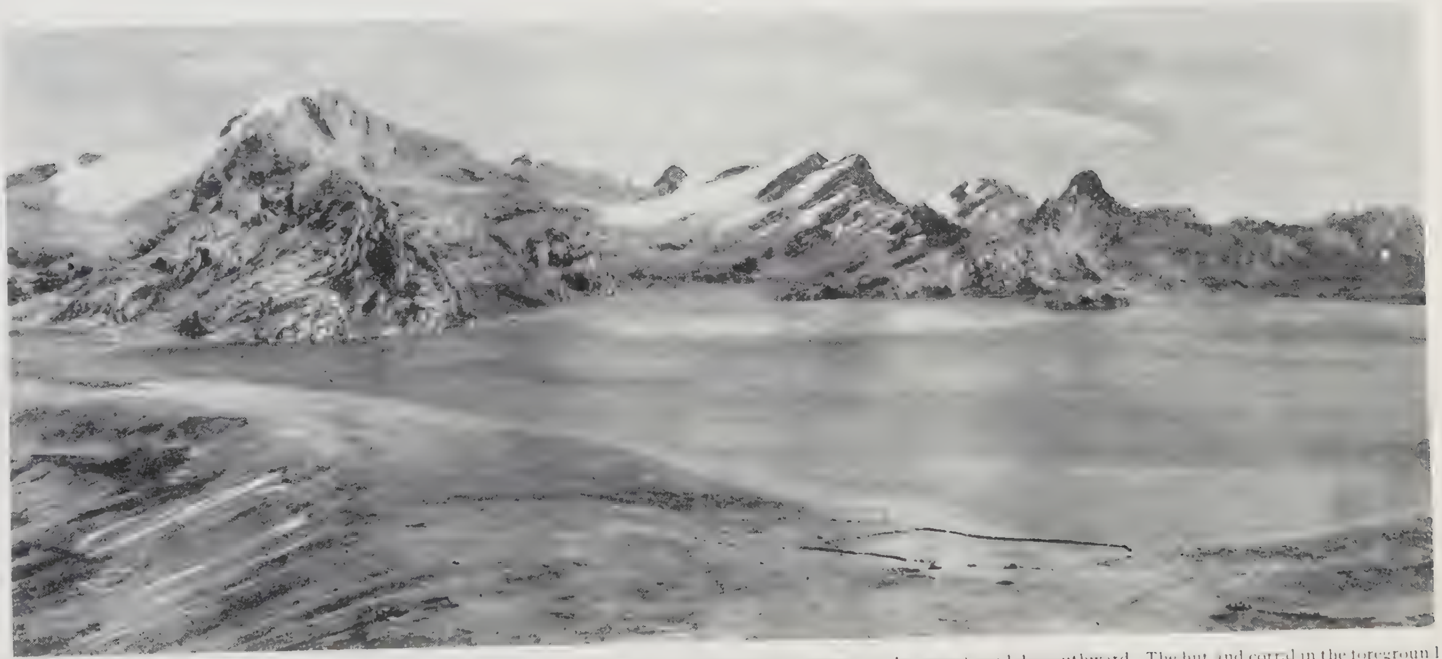

FIG. 12.—Looking northwest across Lake Acacocha. Note the glacial deposit in the foreground, preventing drainage from lake southward. The hut and corral in the foreground to the right furnish a scale.

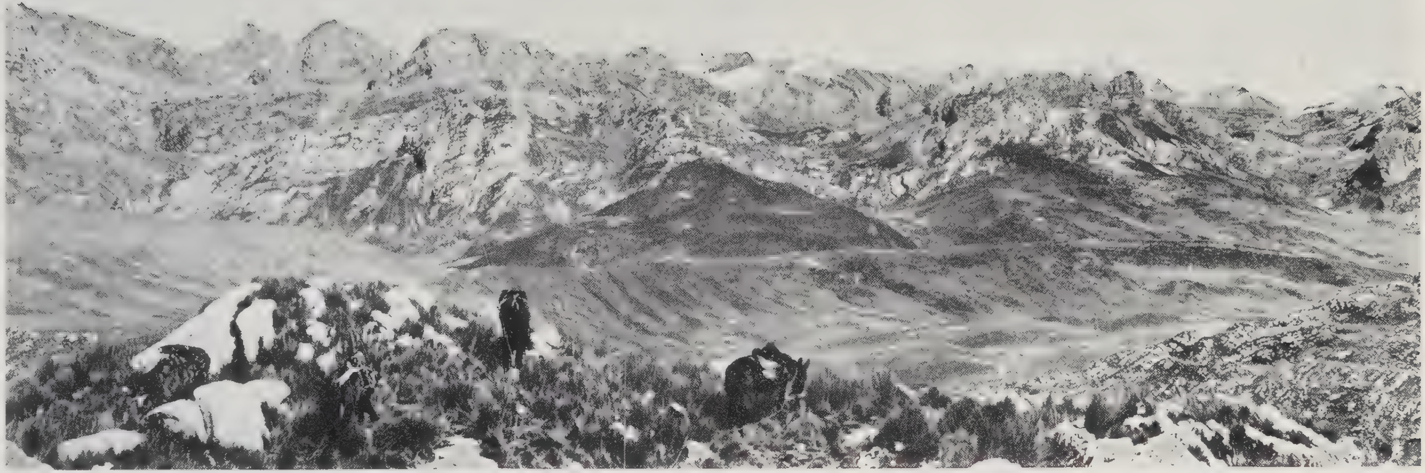

FIG. 13 Looking west from an isolated limestone ridge east of Lake Tucapa. The lake lies at the foot of a grassy quebrada 250 meters below the pampa seen in the photograph and between it and the limestone ridge. The snow-capped peaks on the sky line are part of the main Atlantic-Pacific divide. Compare Figure 6, which is taken from the same spot.

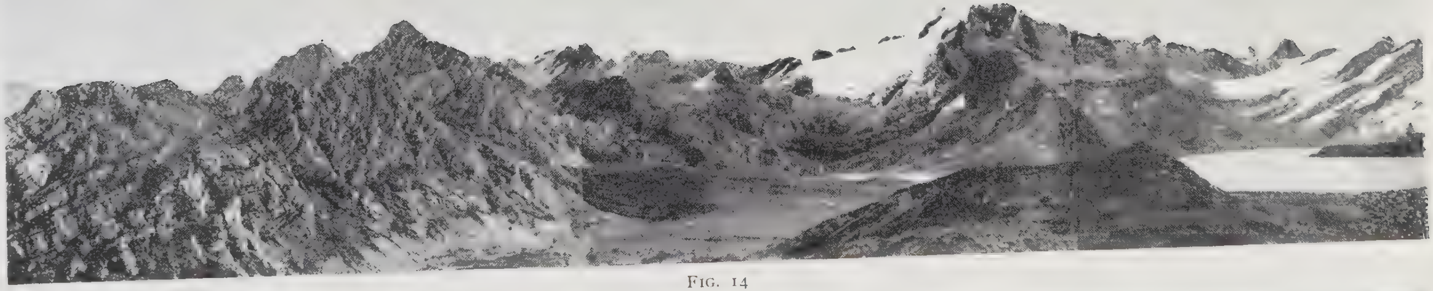

Fig. 14

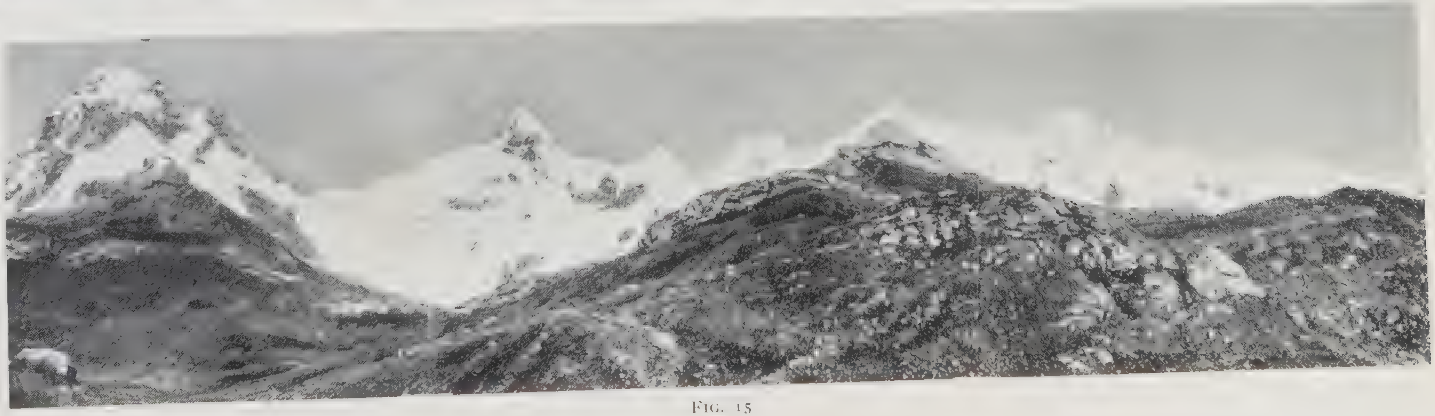

Fig. 15

Fig. 14—Lake Acacocha and vicinity from a hill just east of Lake Punrún.
Fig. 15—Looking west from the upper valley of the River Nupe to the region of high peaks. Carnicero on the right.

almost to their summits. From the most reliable information we could get we gathered that the mountains do not continue far in this direction but eventually descend to the Pampas de Sacramento.

Topographical Reconnaissance of the Mantaro-Huallaga Watershed

When the work at Cerro de Pasco was finished and the positions determined had been plotted on the plane-table sheets, we crossed the plain to its western edge where at Jumashi we were hospitably received by officials of the Vanadium Corporation. Here the main divide rises abruptly from the level of a flat pampa, much higher than the main plateau and separated from it by one or more parallel limestone ridges. On the eastern face of the main divide there are no glaciers or snow, but there is plenty of evidence that this has not always been the case. Some of the higher peaks here, though not exceeding 18,000 feet, have permanent snow and ice on their southwestern faces. As seen from the northeast this presents the curious effect of a thin white rim above the silhouetted rock outline. The most westerly branch of the Mantaro River, the Jumashi, has its source close up under the main divide on one of the high grass-covered pampas, along which it flows until near Mina Ragra, the Vanadium Corporation's mine, it turns abruptly east, cuts through a limestone ridge parallel to the main cordillera, and drops into Lake Punrún. The lake is between seven and eight miles long and at an altitude of 14,100 feet. The Vanadium Corporation carries its ores by a light railway to the western end of the lake and thence by motor launch to the eastern end. Thus Punrún can claim to be the highest navigated lake in the world.

The system of high flat upper valleys between parallel limestone ridges is a characteristic feature of the Atlantic side of the main divide in this region. The eastern faces of the ridges are very precipitous, and lakes nestle at their base. Small streams flow through the limestone country in narrow and crooked gorges in which are numerous little hidden lakes. North of the Jumashi none of these gorges penetrates through to the upper valleys or the main divide until the Colpa Grande, a tributary of the Huallaga, is reached. In this latter valley and others farther north the streams start right at the base of the main divide; they flow in deep glacial troughs that are bordered by high lateral valleys. In one place, for example, north of the Colpa Grande, the streams in the upper valleys drop precipitously 2000 feet into a canyon-like valley which has penetrated through the limestone ridges but no farther.

From Jumashi, skirting the northern edge of Lake Punrún and keeping to the east of the limestone ridges but close to them, we proceeded north along the pampa, crossing the Mantaro-Huallaga divide. Our first camp was on the western shore of Lake Acacocha, 14,635 feet in altitude. We were here several days making side trips into the mountains and becoming accustomed to the altitude. This picturesque lake is the most northerly to drain into the Mantaro River. On its eastern side is comparatively flat pampa extending for many miles to the eastern range of mountains, which can be seen far in the distance. On its other sides it is surrounded by precipitous limestone peaks, the highest of which rises 2220 feet above the surface of the lake. Several small streams flow into Lake Acacocha from other little hidden lakes to the west. Up one of the stream valleys is a trail which crosses over the limestone ridges to the upper pampa, the valley of the Jumashi River. At the pass it skirts one of the few glaciers actually to the east of the main Atlantic-Pacific divide.

As soon as the watershed is passed one notices the feature to which reference has already been made—that the streams flowing north into the Huallaga have cut their valleys far deeper into the surface of the general plateau. Lake Tucapa, still on the dividing line between the pampa and the limestone area, lies at the foot of a grassy quebrada 900 feet lower than the watershed on the pampa but within two miles of it. The stream on which we camped, characteristically fed from this lake at the foot of the limestone peaks, is a tributary of the Yanahuanca River, which flows into the Huallaga at Ambo. The Colpa Grande, already referred to, joins this stream five or six miles farther north. Here is an area of confused topography; but as soon as the glacial trough of the Colpa Grande is crossed one has again the main divide, the high upper pampa, the limestone ridges, and the main plateau clearly differentiated as before.

The particular stretch of upper pampa to the north of the Colpa Grande is ended abruptly by a massive red sandstone spur of the main cordillera. At its northeasterly corner streams collect from all directions to drop 2000 feet into the Chinchi by a series of cascades. The soil on the pampa is composed for a large part of rich red clay and shows evidence of very recent stream erosion in the shallow valleys, 30 to 40 feet deep, with bare sides in places nearly perpendicular.

The main trail from Yanahuanca to Oyon on the western side of the Atlantic-Pacific divide ascends from the canyon onto the upper pampa and thence over the divide by a very low pass. Our route, however, crossed this at right angles. Proceeding by a lateral pass between the main divide and the red sandstone spur, we came into the deep glacial valley of the Anamaray River. On the other side of the valley one is confronted by the big snow-clad range which culminates in the Raura peak. Our problem was to reach the source of the Marañon River at Lake Santa Ana, which lies directly the other

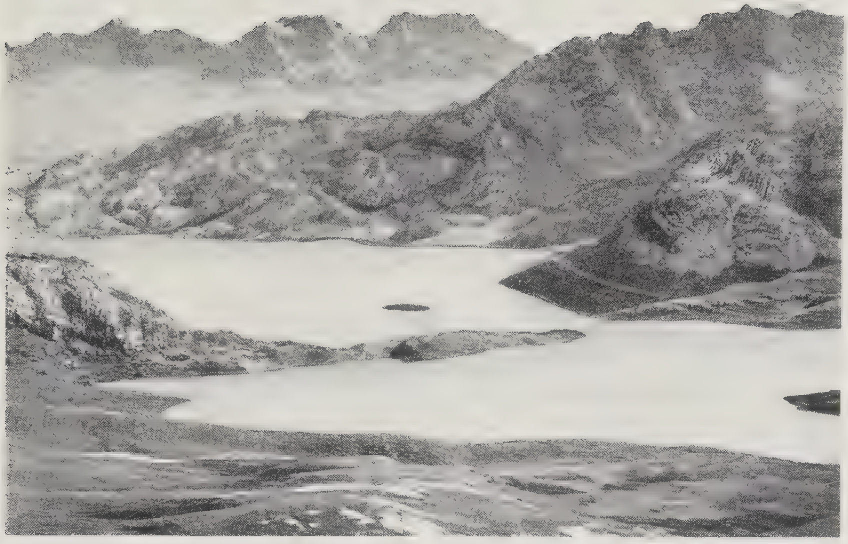

FIG. 16

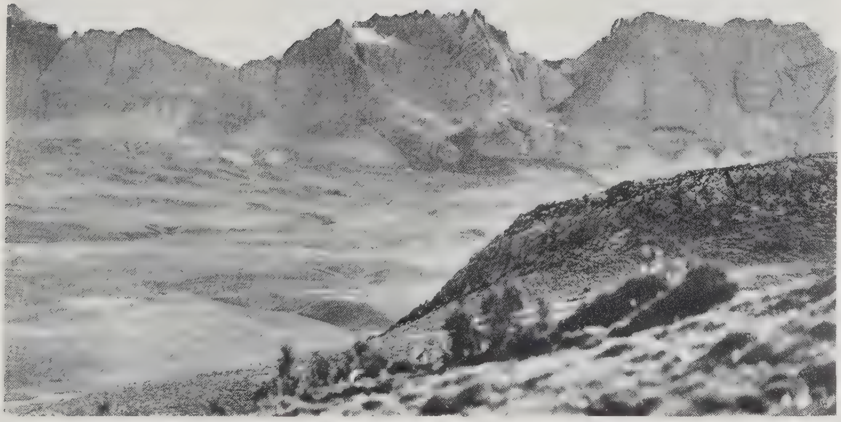

FIG. 17

FIG. 16—Looking west across northwest corner of Lake Punrún. Note the cirques of the main Atlantic-Pacific divide in the distance and the high upper pampas between the divide and the limestone ridge of the foreground. Through the latter the Jumashi River has cut a gorge (see left of picture).

FIG. 17—A closer view of the Atlantic-Pacific divide and upper Jumashi pampa. Compare Figure 16.

side of Raura. The best approach lay round the western side of the peak, or across the Atlantic-Pacific divide. The high lateral valleys on the Pacific side we found distinctly different from those just left. Glaciers and snow fields were much in evidence. About eight miles to the north, at the head of a small lateral valley, we were confronted by a group of very high peaks and glaciers; but a trail was found which ascended to the east. At the top of the rise we found ourselves looking down a few hundred feet into beautiful little Lake Potosí at the foot of a large glacier coming off Raura peak. Lake Potosí is completely surrounded by glaciers and loose shale hills and has no visible drainage outlet, though a fast-running stream from another little lake to the west, also glacier-fed, flows into it. No doubt the drainage from the lower lake is subterranean: but do its waters flow into the Huallaga or the Marañon or the Pacific?

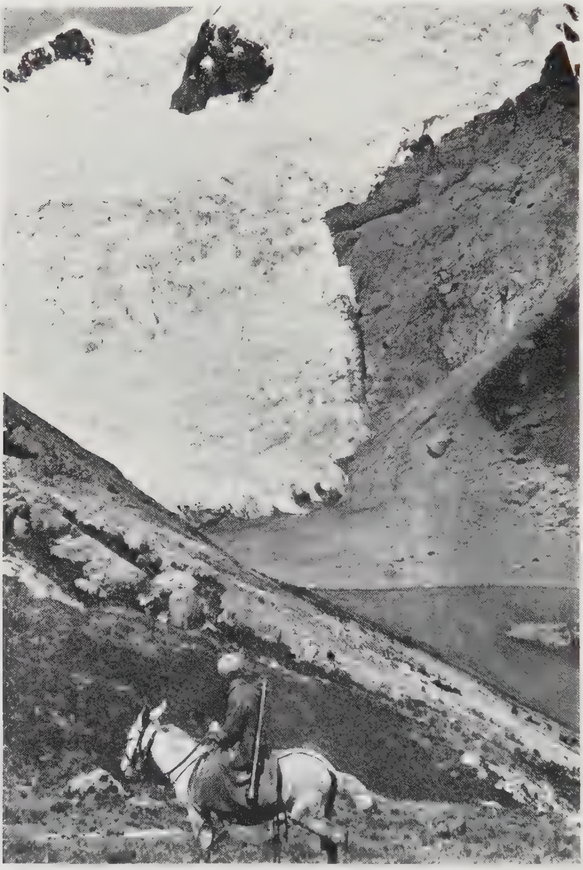

FIG. 18—Lake Potosí from the west.

Two miles north across loose shale hills we dropped down into the glacial basin of Lake Santa Ana. This lake is held to be the true source of the Amazon, justly so in my opinion. Towering directly above are snow-capped peaks rising over 2600 feet above its surface, and an enormous glacier abruptly terminates on the lake's edge in a solid wall of ice judged to be at least 100 feet high. We camped by it for several days and were often wakened in the night by the deep boom of ice falling into the water.

A silver and lead mine has just been started at Santa Ana. No ore had as yet been extracted. It is proposed eventually to transport it by llama pack train to Oyon west of the Cordillera, whence the Pacific coast is reached at Huacho.

The valley from Lake Santa Ana turns to the north, and one passes a succession of gloomy lakes. To the southeast is a comparatively flat glacier on the Raura massif. It is the one by which Miss Annie Peck climbed a peak of the mountain in 1906.[3]

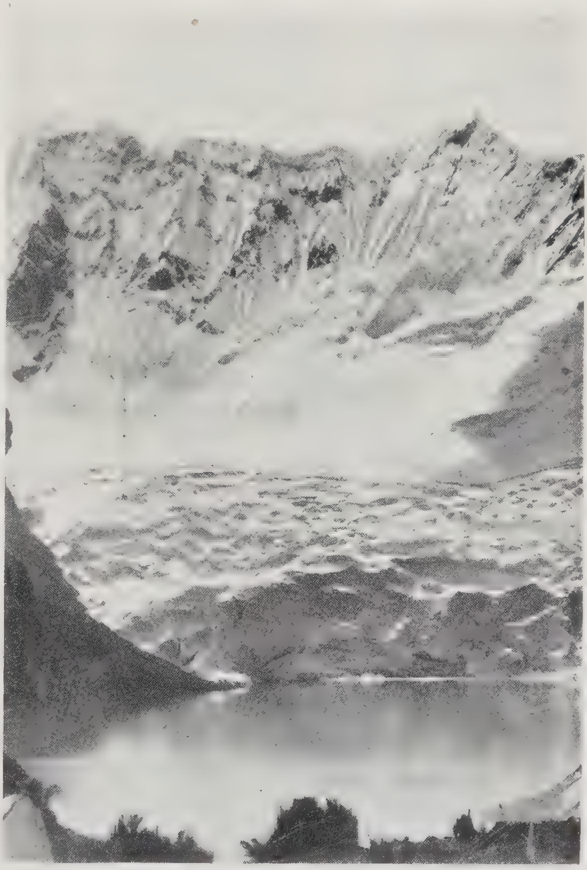

FIG. 19—Lake Santa Ana from the south.

The trail is poor and at the northern end of Lake Tinquicocha leaves the valley and proceeds in a northeasterly direction to Lake Lauricocha by way of the valley of the Yantac River. A former trail that followed the main stream has been deliberately destroyed by the owners of the ranch at Antacallanca to prevent the depredations of cattle thieves. We sent the baggage mules round by the ordinary trail and ourselves succeeded in going down the main quebrada. Previous maps we found to be entirely unreliable: the number and position of the lakes were not shown correctly, the long gorge between lakes Patarcocha and Lauricocha has never been indicated, nor a series of lakes to the west of Patarcocha. We made a side trip of several days up into the unexplored lake country and across a high divide to the valley of the Nupe River, which has its source close to the awe-inspiring Carnicero.

This ended our work in the high mountain region, and we returned to Lake Lauricocha, camping at the eastern end for several days. The lake itself is considerably longer than estimated by Sievers[4] and trends more west-east than southwest-northeast in direction. The eastern end of Lake Lauricocha, whence issues the Marañon to flow northward, is only a few hundred feet below the surface of the surrounding plateau, the mountainous region having been left halfway down the lake. The main trail between Yanahuanca and Huallanca crosses the Marañon just below Lake Lauricocha by a bridge, supposed to be of Inca construction, and the part of the trail between Lauricocha and Huallanca was the route proposed by the Intercontinental Railroad Commission in 1894.

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[3] A. S. Peck: A Search for the Apex of America, New York, 1911, Chapters 22 and 23.

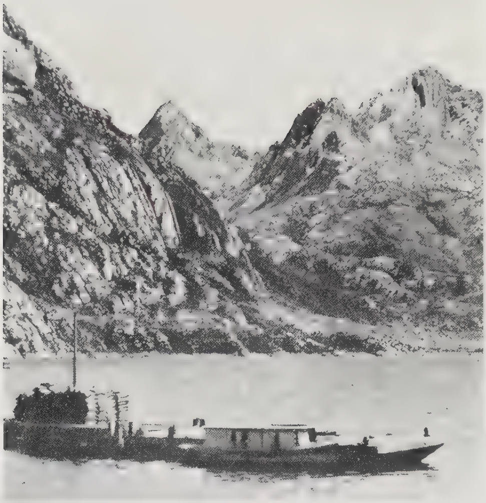

FIG. 20

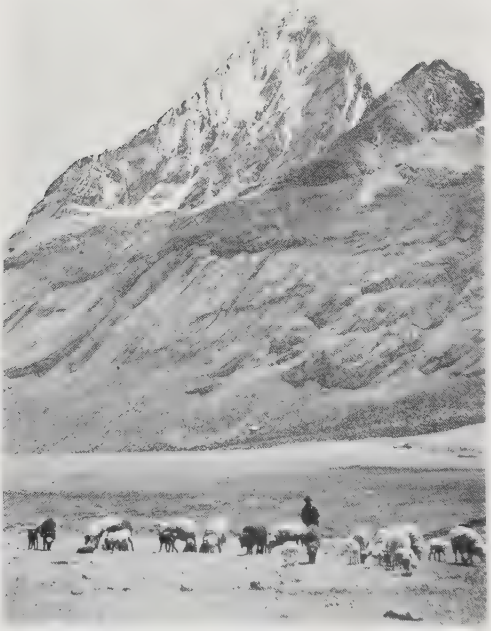

FIG. 21

FIG. 20—Wharf on Lake Punrún.
FIG. 21—An isolated peak south of Lake Potosí, photographed from the west.

WEATHER ON THE PLATEAU

At Cerro de Pasco on the eastern side of the plateau and at more or less the same height as the camps we occupied in the mountains, the average daily mean temperature over a period of 14 days in July (14–27) was about 43° Fahrenheit with a maximum of 63° and a minimum of 20°.[5] We experienced the greatest extremes in temperature while on the western edge of the main plateau, undoubtedly because of the fine weather and the comparatively low humidity. In the mountains during August and September, when we had a great deal of bad weather, though the average daily temperature remained about the same the maximum and minimum had a much smaller amplitude.[6] The greatest 24-hour range, from 64° to 14° (Aug. 18), was at Lake Tucapa, where we also experienced the lowest relative humidity with an average daily mean of 53 per cent over four days (Aug. 17–20), the highest observation being 84 and the lowest 19. The observations were for the most part taken in camp, that is to say in sheltered places, and the average daily mean temperature was just over

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[4] Wilhelm Sievers: Reise in Peru und Ecuador ausgefuhrt 1909, *Wiss. Veroffentl. Gesell. für Erdkunde zu Leipzig*, Vol. 8, Munich and Leipzig, 1914, p. 29. He is followed by Pierre Denis in a map of the sources of the Marañon, Amérique du Sud (Géographie Universelle, Vol. 15), Part II, 1928, p. 291.

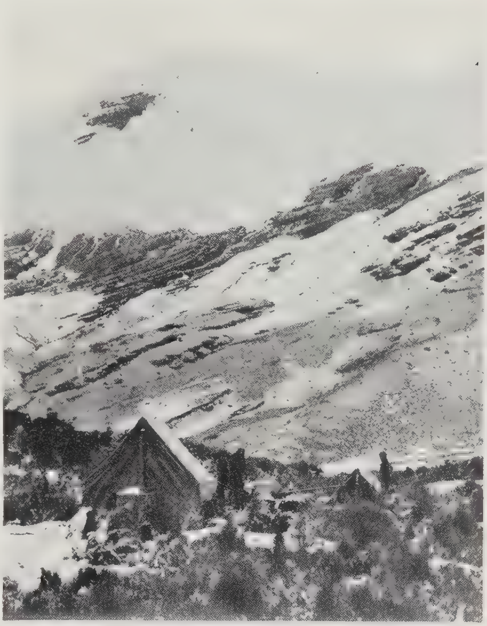

FIG. 22

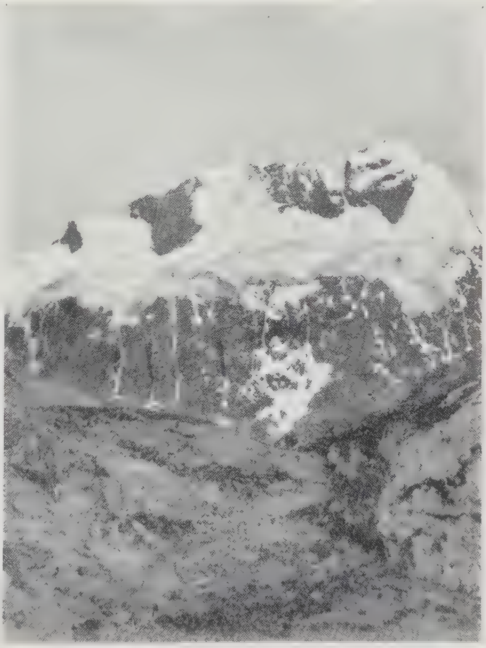

FIG. 23

FIG. 22—On the Pacific side of the Anamaray pass looking east.

FIG. 23—Above Lake Potosí (Fig. 18) looking east.

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[5] Observations in 1908 at Cerro de Pasco gave the monthly mean temperature in July as 38.6° F., the absolute extremes as 60° and 21°; for the year the mean as 42.6° and extremes as 69° and 21° (Fritz von Kerner: Temperatur- und Regenmessungen aus Peru, *Meteorol. Zeitschr.*, Vol. 34, 1917, pp. 29–34).

[6] Compare records for the station of Morococha, in latitude 11° 45′ S. and immediately east of the crest line of the Maritime Cordillera (Isaiah Bowman: The Andes of Southern Peru, New York, 1916, pp. 171–173).

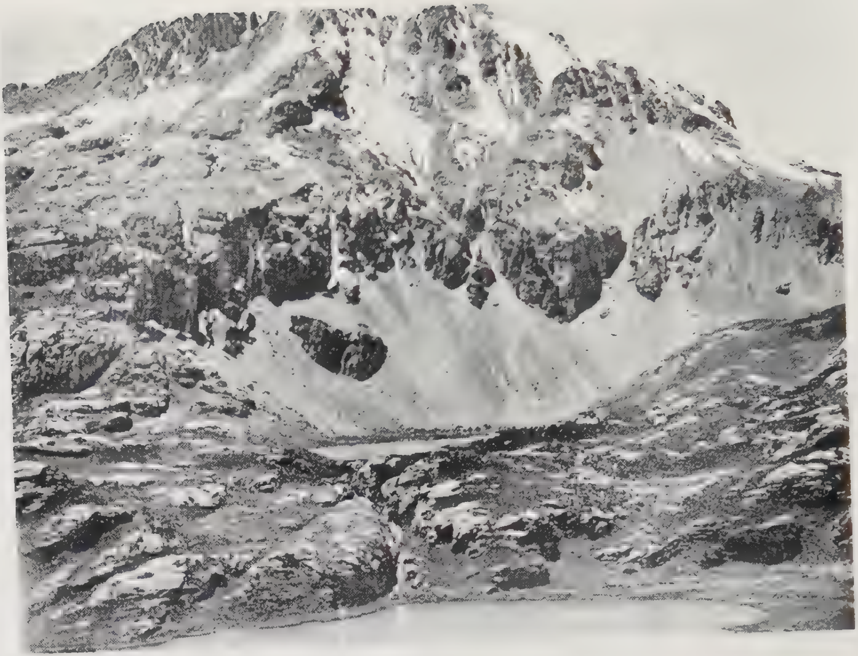

Fig. 24

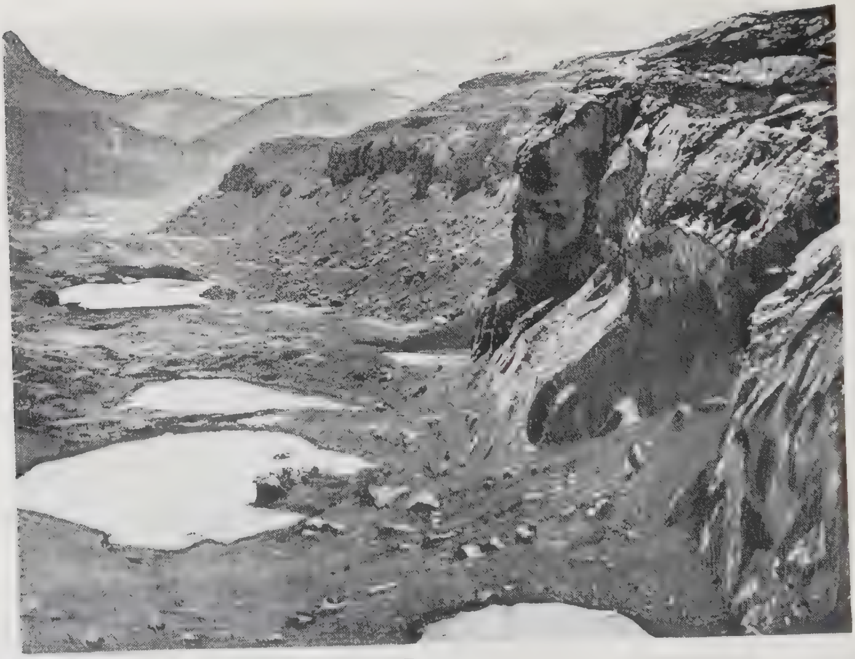

Fig. 25

Fig. 24—Glacial erosion in the Anamaray Valley looking across the valley to the south.
Fig. 25—The Anamaray Valley looking northeast down the glacial trough.

40° F. as at Cerro de Pasco. Nothing lower than 12° F. (Lake Tucapa, Aug. 19) and nothing higher than 70° (at Camp 5, Sept. 3) was experienced in the whole of this mountain region.

The first two or three weeks after leaving Jumashi we had almost perfect weather. True, there were occasional snow flurries; and during this period a heavy mist settled completely over the landscape before sunrise, often not clearing off until nine o'clock in the morning. The snowstorms and thunderstorms came on in the middle of the afternoon, and after nightfall it would clear again.

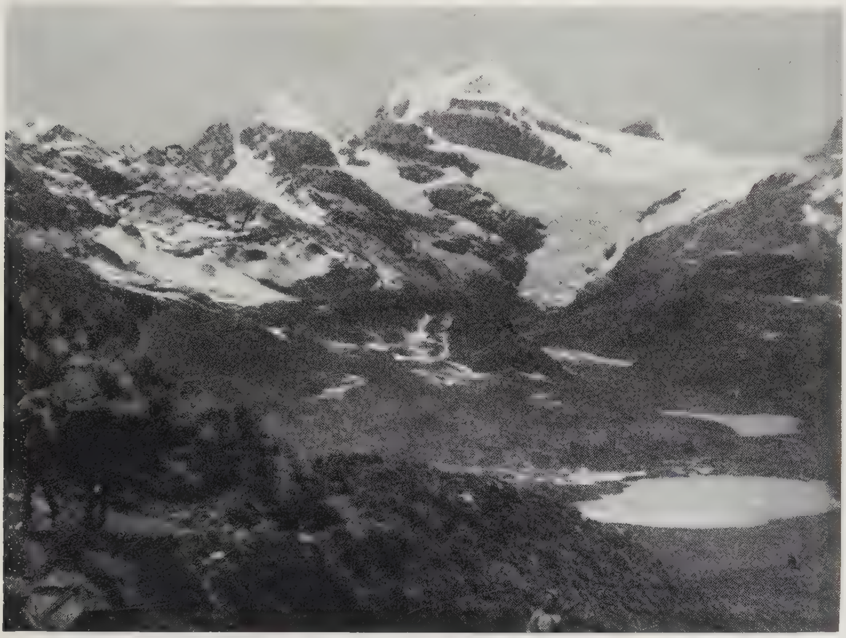

FIG. 26—The unmapped lakes west of Lake Patarcocha.

For a week on the upper pampa above the Chinchi canyon we saw the sun rarely for more than a few minutes; for the rest it was a succession of storms—snow, sleet, hail, rain, and thunder. But so powerful was the sunshine that not more than half an hour was required to remove all traces of a storm.

When we arrived at Lake Santa Ana, though it had been raining hard earlier in the day, the sun was shining brilliantly, and it was pleasant to stretch out full length on the warm grass. Half an hour later a black storm came rushing up the valley, and in a very short time the ground was covered with several inches of snow. There were many similar experiences of these characteristically sudden changes of weather. One is tempted to quote Wiener's description of the weather at Cerro de Pasco: "son ciel, dans une seule journée, dans

une seule heure souvent, paraît tantôt du bleu le plus transparent, tantôt noir; il envoie tour à tour des rayons brûlants, de la grêle, de la neige, de la pluie torrentielle, des éclairs enveloppant la ville entière, qui reparaît instantanément après, par l'effet d'un coup de vent, dans une splendeur incomparablement sereine."[7]

THE PEOPLE OF THE REGION

There were a great many more people living in this region than we had expected to find, amiable and friendly people, too. We had been warned to expect hostility before going into this country, and many were the uncorroborated tales of the killing of large bodies of Peruvian soldiers by the outlaw inhabitants. They originated I think from the fact that there had been a group of bandits in this region some years before who, besides preying on the local inhabitants, stealing their sheep, and plundering generally, had killed a Peruvian officer and several soldiers.

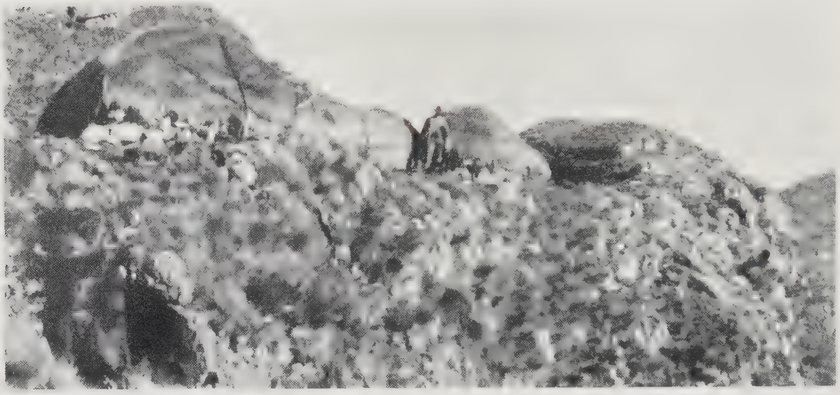

FIG. 27—Indian huts near the unmapped lakes shown in Figure 26.

In the lower valleys the larger landowners maintain stock farms, and in the more remote regions the Indians themselves raise sheep and pigs; but habitations of one sort or another seemed to be everywhere. Though we had our own food supplies with us it was always possible to get fresh mutton. There is a law in Peru that a wayfarer if hungry may kill a sheep provided he pays the owner the sum of 1 sole, 50 centavos (approximately 56 cents). We took advantage of it on several occasions.

From Lauricocha we crossed the main plateau and came to the coal mines belonging to the Cerro de Pasco Company, where by means of the independent triangulation made there we were able to check up on the triangulation observations that had originally been made at Cerro de Pasco. This finished our work in the high mountain region.

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[7] Charles Wiener: Pérou et Bolivie, Paris, 1880, p. 226.

HIGH VALLEYS OF THE EASTERN BORDER

If we were surprised by the number of people inhabiting the high mountain area, we were still more surprised by the density of the population in the Yanahuanca and Huallaga quebradas above Huánuco. It is surprising that among the various routes that have been suggested for a concrete road or railway between Lima and the head of Amazonian navigation a route via Oyon and the Yanahuanca quebrada to Huánuco and beyond has not been proposed, for the population of the Yanahuanca quebrada is certainly much more dense than any portion of the Nudo de Cerro de Pasco over which most of the proposed routes would pass.

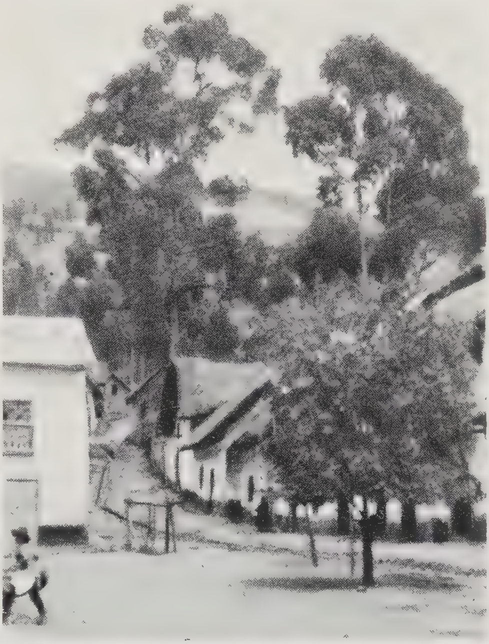

FIG. 28—A street scene in Yanahuanca.

The Yanahuanca district raises live stock in large numbers and crops, principally of the cold zone, potatoes in particular,[8] for which a ready market is found in Cerro de Pasco and the coal-mining centers of Goyllarisquisga and Quishuarcancha. The population lives not in separate groups of houses, as in the mountains we had just left, but in large villages that might almost be called towns.

The center of the district is Yanahuanca, a picturesque and comparatively clean place. It is built on a level with the river of that name, whereas most of the other towns and villages are perched on the sides of the quebradas which in this neighborhood are several thousand feet deep. As yet there is no motor road approaching Yanahuanca, but the trails are broad and good. The town has good stores and telegraphic communication with Lima. There is a Sunday market; and a fair, principally of live stock, is held on July 22 each year. The people of the district also resort to Cerro de Pasco for their shopping, taking the train there from Goyllarisquisga.

Coming down into the high border valleys from three months in the Puna it was exhilarating to see occasional trees, potatoes, and

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[8] Dueñas, *op. cit.*, p. 129.

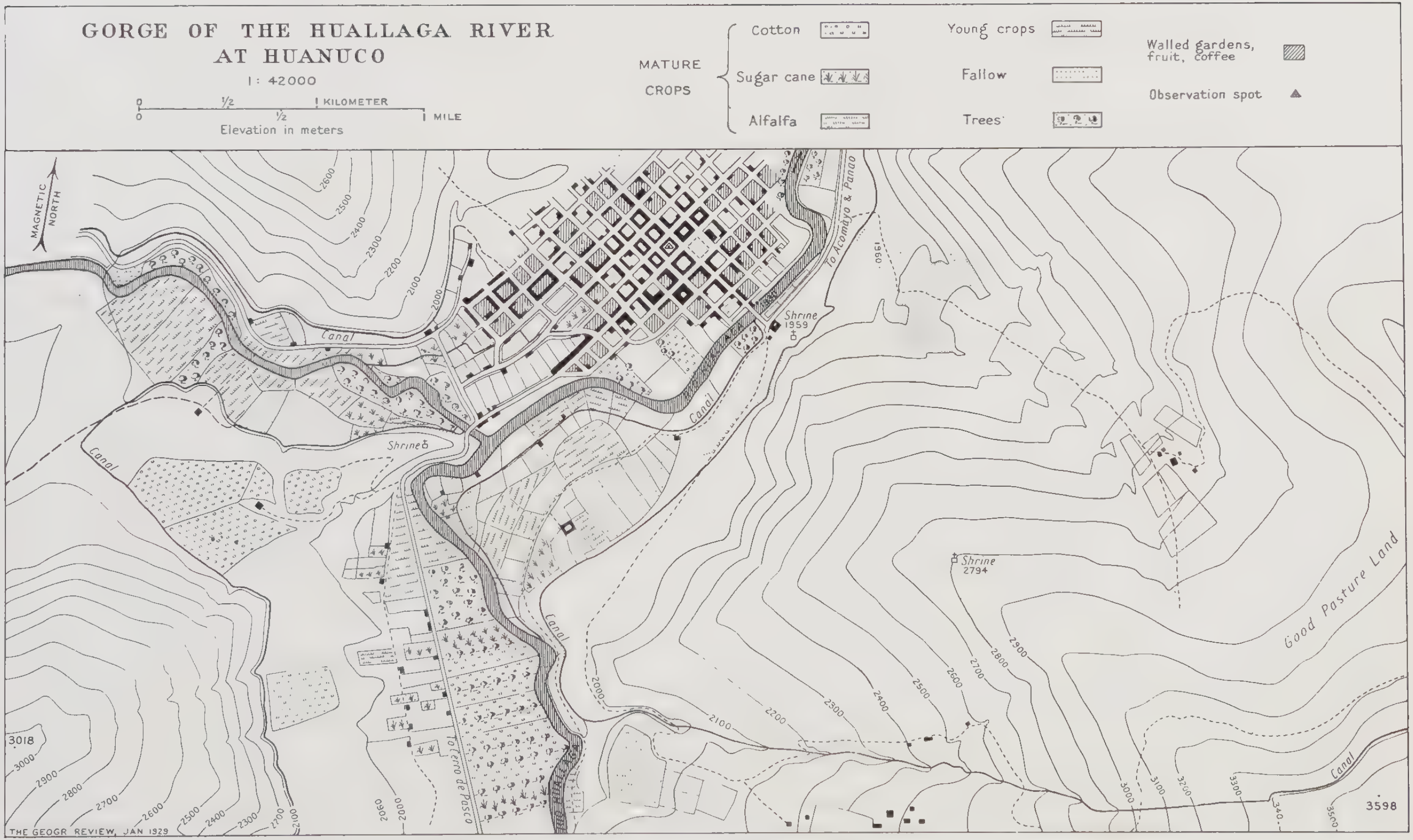

FIG. 29—Map showing topographical and cultural features of the gorge of the Huallaga at Huánuco. The map is accurately located by astronomical observations taken in the courtyard of the Hotel Inca: Latitude 9° 55′ 27″ South; Longitude 76° 14′ 12″ West. The datum level is taken at the bridge over the Huallaga, 1930 meters.

vividly green alfalfa. As Wiener says: "Il est extraordinaire comme des arbres meublent un paysage." There were also many beautiful flowers such as grow in gardens with us—roses, geraniums, arum lilies, gladioli. Nevertheless the country in these high secondary valleys is semiarid, as is evidenced by the predominating growth of cactus.

Huánuco and the Huallaga

From Goyllarisquisga we returned to Cerro de Pasco for a reconnaissance trip into the montaña, which we entered by way of Huánuco. Huánuco is the capital of the department of that name and is a well laid out city, historically interesting as it was founded only four years after Lima.[9] The estimate of 1896 credited Huánuco with only 6000 population, less than half the population of Cerro de Pasco; but the writer judged the cities to be now about the same size. Huánuco is situated on the Huallaga at an elevation of 6400 feet above sea level and about 40 miles above the gorge of Piedra Grande, where the river turns north. The valley of the Huallaga at Huánuco is very deep, the immediate mountains rising 5000 feet above the valley floor to what is really the height of the main Andean plateau in the region. There are, however, individual mountains in the vicinity higher than this general level.

Irrigation in the Huánuco district is entirely artificial, irrigation canals being led off the main river and the side branches at suitable points. Much ingenuity has been expended over their construction. The deep valleys of the eastern Andes are semiarid. Without irrigation systems of this sort the quebrada of Huánuco would be almost a desert. Though no rainfall statistics are available it is very evident that the annual precipitation is extremely small. The lower sides of the quebrada have no vegetation at all growing on them except occasional cactus. The upper slopes have grass nearly all the year round.

The main valley floor is comparatively flat, the river meandering in broad sweeps from side to side. The current is rapid, there being few if any quiet reaches of deep water. Between the steep mountain sides and the valley floor are frequent remains of an upper alluvial terrace in which canyon-like watercourses, now generally dried up, are cut. The valley floors of the side quebradas, if such a name can be applied to such very steep slopes, are comparatively smooth except where cut by very recent stream erosion.

This whole region is purely agricultural. The bulk of the cultivation seems to be in the less steep side quebradas. Here alfalfa is a favorite crop. In the main valley citrus fruits, pineapples, and bananas are grown, mostly in and around the town of Huánuco or behind the high walls of the *haciendas* of the larger landowners in this neighborhood. Much sugar cane is to be seen, and cotton is also now being grown extensively but only on the large estates. Huánuco coffee is famous, though much exported under the name is grown much farther down the river, as that on the *haciendas* of Sr. Antonio Trujillo on the eastern side of the valley, some miles below Piedra Grande. On the western side of the Huallaga between Acomayo and Tingo Maria there are, I understand, coca plantations. A certain amount of timber, mostly eucalyptus, is also taken from this region for use in Cerro de Pasco.

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[9] Compare the description in E. W. Middendorf: Peru, 3 vols., Berlin, 1893–95, Vol. 3, pp. 129–133.

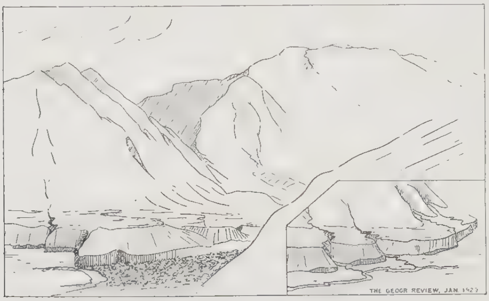

FIG. 30

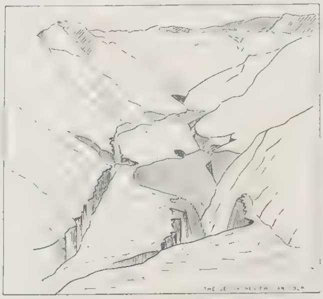

FIG. 31

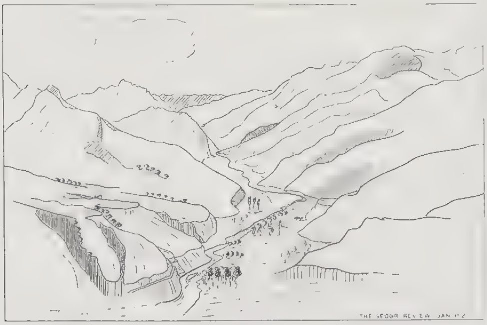

FIG. 32

FIGS. 30–32—Diagrammatic sketches at Huánuco and vicinity. Figure 30 is looking up the Huallaga to the west of Huánuco; the inset shows general appearance of the alluvial terraces bordering the main quebradas. Figure 31 is looking up one of the steep side quebradas. Figure 32 is looking up the Panao River above Panao.

The valley floor of the Huallaga at Huánuco is nearly a mile wide. As one proceeds down, it first widens a little then narrows into a gorge which continues beyond the big bend of the Huallaga at Piedra Grande. There are several small towns below Huánuco; the largest of them is Panao, on the southeast bank of the river of the same name, a few miles above its confluence with the Huallaga. The town has a sub-prefecture and is in connection with Huánuco by telegraph. North of Panao and high up on the eastern side of the quebrada is the small town of Chaglla. This is the last outpost of the semi-dry agricultural zone. Within a few miles the montaña begins. There are no trees at Chaglla: potatoes and alfalfa are grown, and there is good coarse grazing grass. As soon as one begins to descend into the gorge to the north one passes through a belt of mixed trees and open grassland into drier vegetation with cactus and, where there is cultivated ground, bananas, pineapples, and yucas. At the foot of the gorge cactus plants are the only form of vegetation.

The dividing line between the dry, pastoral sierra country and the wet, tree-covered montaña is the most striking feature of the region. The line is distinct, and the general direction parallels the main cordillera. Much higher than Chaglla and immediately to the east of the Huallaga gorge are the high peaks of the eastern range. Trees cover them everywhere except where the bare rock protrudes a few hundred feet at the top and on the swampy, grass-covered pampa of Tambo de Vaca. The height of the tree line varies greatly from place to place.[10]

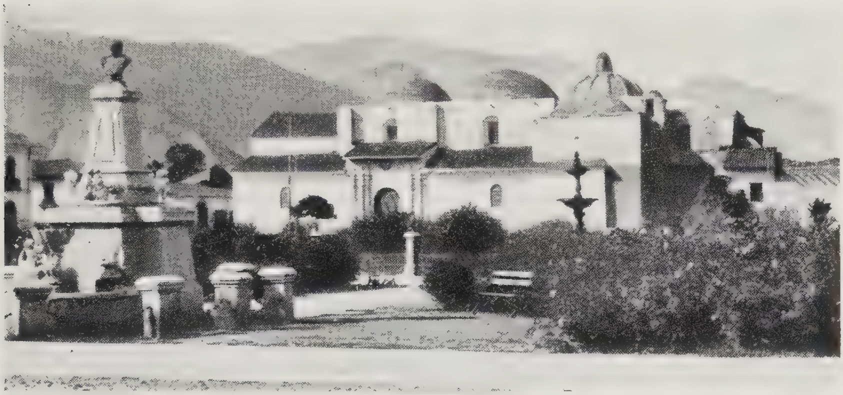

FIG. 33—The Plaza, Huánuco.

On the top of the range at Tambo de Vaca it rains nearly all the time except perhaps in April, May, and June: on the other side there is a delightful temperate zone at about 6000 feet. Again I observed our garden flowers—fuchsias and begonias, for instance—growing wild; and this country is a paradise for the butterfly collector. It was on the eastern slopes of the Tambo de Vaca range that we first came in contact with the well known German colony on the Pozuzo River—at the *hacienda* of Sr. Ballesteros at Cushi. Sr. Ballesteros was formerly an officer in the Peruvian army and has married into the colony. I mention him because he has settled in a rather different fashion from the rest.

THE GERMAN COLONY

Some seventy years ago, encouraged by the Peruvian government, by the offer of free land, and by soil and climatic conditions reputed so

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[10] Compare similar variation in the Urubamba Valley depending upon insolation as controlled by slope exposure and upon moisture controlled largely by exposure to winds (Bowman, *op. cit.*, pp. 71 *et seq.*).

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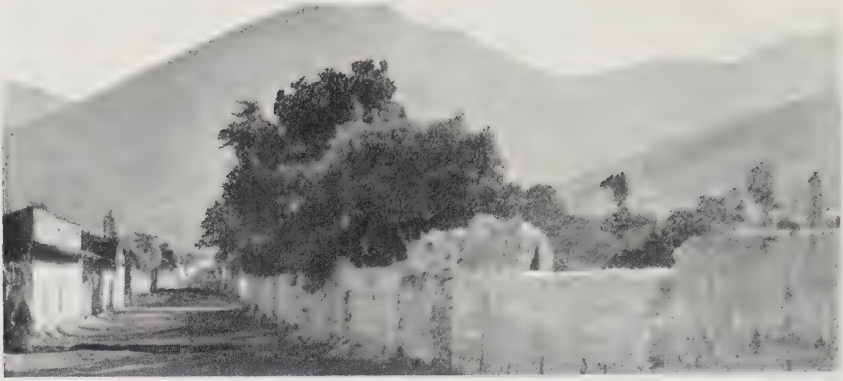

FIG. 34

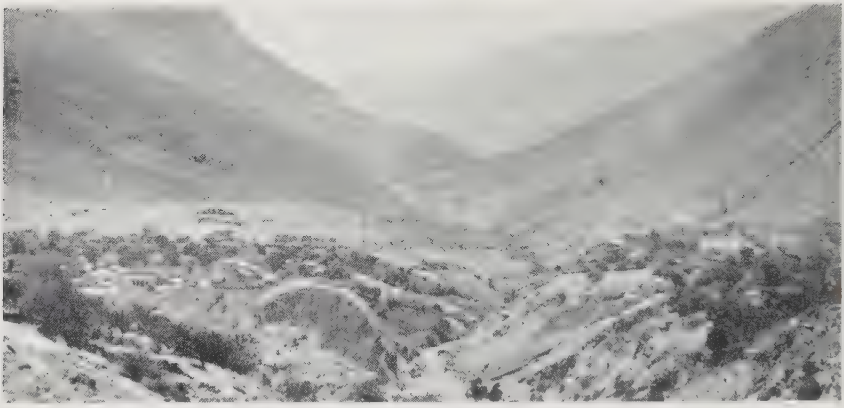

FIG. 35

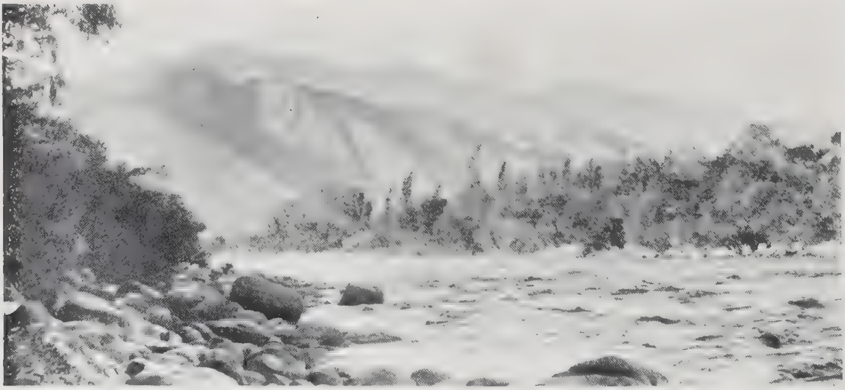

FIG. 36

FIG. 34—A street in Huánuco.

FIG. 35—Looking north up a side quebrada from the main Huallaga valley several miles below Huánuco

FIG. 36—Looking east down Rio Huallaga from Huánuco. In the semiarid quebrada region. Compare Figure 39.

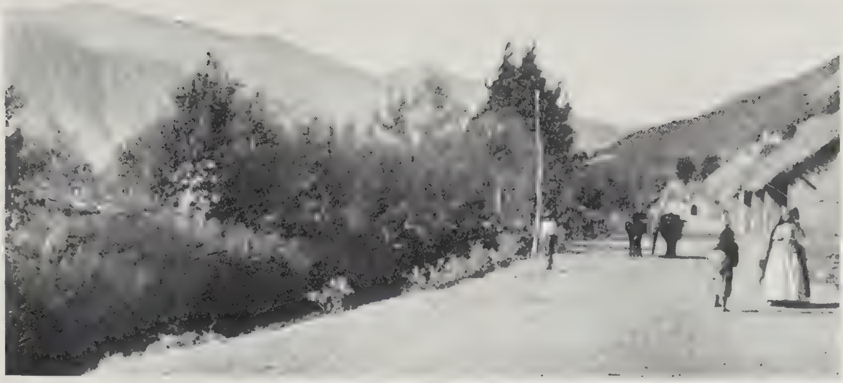

Fig. 37

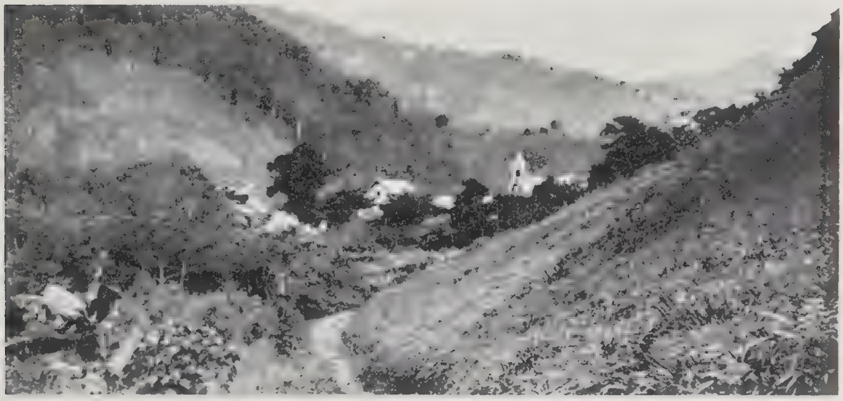

Fig. 38

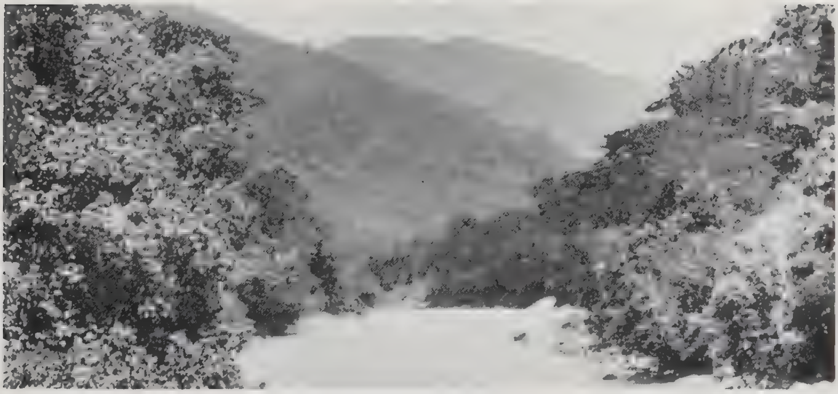

Fig. 39

Fig. 37—On the road between Huánuco and Acomayo.

Fig. 38—The center of the Pozuzo colony.

Fig. 39—Looking north down Rio Huancabamba three miles south of its confluence with the Pozuzo. The montaña region. Compare Figure 36.

favorable that anything might be cultivated, some hundreds of Germans, Catholic peasants from the Tirol and Rhineland, were persuaded to settle on the Pozuzo River near where it is joined by the Huancabamba. Eighty families arrived in 1857, a similar number some few years later. The population now totals about 600 persons. It is very much scattered, each family having its own farm. The center of the colony is not a town but simply consists of a church, a store, a school, and one or two houses. We had heard much in Huánuco about the degeneracy of the colonists, but our first impressions pointed in an exactly opposite direction. One cannot but be impressed on entering the colony by the main trail to notice the well constructed houses, well cultivated land, and the general aspect of tidiness. Picturesque suspension bridges have been built over the Pozuzo and the Huancabamba rivers; and the trails, after the wretched experiences we had endured on the other side of the mountains, seemed very well kept. It was surprising to meet, in such a situation, an extremely blond, beautifully complexioned girl cleanly dressed in white, walking down the trail and carrying a pail in each hand like the traditional Tyrolese milkmaid.

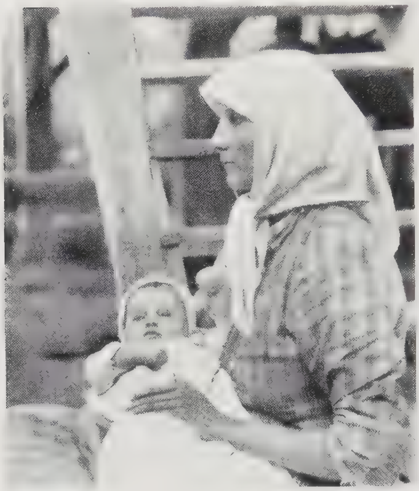

FIG. 40—A young woman of the German colony at Pozuzo.

The houses that we first visited near the center of the colony were those of the older generation, and one saw well made chairs, carved doors, religious pictures, family photographs, and every indication that the people loved their homes and were proud of them. The church had been almost entirely built by the priest himself, and there were two stained glass windows which had been brought from overseas. The colonists adhere closely to their religion, and one sees them all at church on Sunday. The children living near by attend the school four days a week; on the remaining days the school-teacher travels on muleback to an outlying district of the colony, there to teach the others. They are taught to speak Spanish, but they read the Bible in German.

These were our first impressions, and we saw Pozuzo as a veritable little paradise. However, we were inclined to be disillusioned later, though the state of affairs was by no means as bad as we had been led to expect. The great quantity of raw cane alcohol drunk by the men has had a deleterious effect on the physique of the second and third generations, though there are still plenty of fine, upstanding people in the colony. The women seem very much more healthy.

The governor of the colony is an Indian, as it is against the constitution of the country that any one not Peruvian-born should hold this office, but the mayor is of German extraction; the priest is German-born, and he revisited his native land as recently as 1924. He has been with the colony for thirty years and, besides being the spiritual guide, is doctor, storekeeper, and what you will. Only two or three of the original colonists are now alive, but the old manners and customs are still maintained, and the styles in clothes are those, one gathers, of 1860. After church on Sunday the people gather round the little store, buying their simple needs from the priest. One notices a certain amount of Indian blood; but there has not been much intermarriage with the Indians: it has evidently been frowned upon.

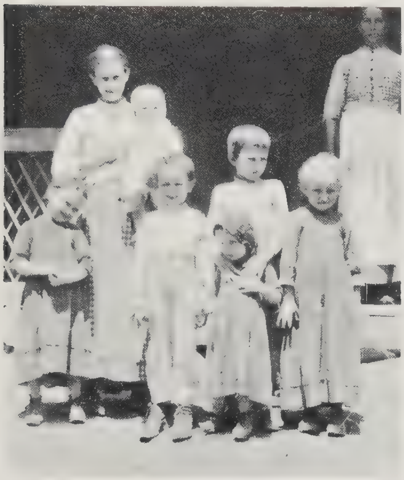

Fig. 41

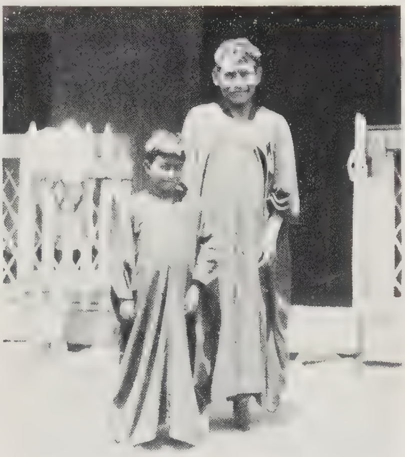

Fig. 42

Fig. 41—Women and children of the German colony at Pozuzo, established 70 years ago.
Fig. 42—Indians from the Puerto Victoria district at the junction of Pichis and Palcazu.

There are many reasons why this colony has not developed successfully. The most obvious, no doubt, is its inaccessibility;[11] but the climate plays an important part. These Germans have been accustomed to a rigorous winter. The continual summer apparently has undermined their constitutions. The colony is situated at too low an elevation: the altitude is only 2800 feet. Sr. Ballesteros lives in the really healthful zone at 6000 feet. Moreover he has made the Indians work for him. The Germans have not done so.

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[11] Otto Nordenskjöld: Sudamerika: Ein Zukunftsland der Menscheit, Stuttgart, 1927, pp. 196–197.

Communications with the Amazon: Puerto Leguia

Automobile road building is progressing in the upper Huallaga Valley region. There is quite a good road between Cerro de Pasco and Huánuco, and this already has been continued down the Huallaga Valley to Acomayo, whence a branch is being constructed across the hills to Panao. Other short sections of road are in existence from Huánuco to the west, and a road is being built from Goyllarisquisga into the Yanahuanca quebrada, where excellent trails exist. It is only when one approaches the montaña that poorer trails are encountered. The principal route between Lima and Iquitos used to be via Huánuco and Pozuzo, along the Huallaga Valley to Muna and thence over the tops of the mountains in a more or less straight line to Pozuzo. Though not the easiest, it was the shortest route. When the road to La Merced was built the main route to Iquitos changed, and every one now goes by way of Tarma and La Merced. The old trail has fallen into disrepair, and the route to the colony is now fantastic in the extreme.

Various projects whereby Puerto Leguia on the Rio Pachitea is to be connected by road or railroad with Lima have lately been discussed. One of these schemes shows a route directly through Pozuzo. At present Pozuzo people wishing to go towards Iquitos travel by way of Chuchuras on the Rio Palcazu, to which place there is a moderate trail.

We took the old route by way of Puerto Mairo, which has been neglected for years and can hardly be called a trail any longer. Puerto Leguia is a recently established colony. It is sufficiently far down the Rio Pachitea to allow regular communication with Iquitos by small steamboats. An attempt was made two or three years ago to colonize it with Californian farmers, but very few of the hundred or more families stayed longer than three or four months. But Peruvians look on the place as a future port for communication between Lima, the sierra country, and Iquitos. In Lima I was told by the promoter of the Puerto Leguia colony that 60 miles of a new trail had already been cut across the Pampas de Sacramento from Puerto Leguia in a straight line towards the big bend of the Huallaga. If this trail is ever completed it will cross the mountain range at a much lower altitude than the old one and will form part of an admirable route between Lima and Iquitos. The chief advantage of this route, apart from its directness, is the fact that between the Huallaga and the Pachitea no streams of any considerable size have to be crossed.

At Puerto Mairo, Chuchuras, and Bermudez, where the trails end at present, all traffic is continued by water. The rivers in these regions are swift and liable to sudden rise and fall of many feet even in the course of a night. The mail boat coming up from Iquitos, drawing over four feet of water, often is compelled to stop at Puerto Victoria owing to the low state of river, and the journey is continued to

Puerto Bermudez up the Rio Pichis by canoe. It seems strange that no intermediate-sized craft has been used on these rivers. Nevertheless one of the main reasons given for the underdevelopment of this region is the difficulty of navigation.

Puerto Victoria lies at the point where the rivers Pichis and Palcazu join to form the Pachitea. Here is the trading station and comfortable *hacienda* of Sr. Walter E. Buttgenbach, who owns a large concession on the northern bank of the Palcazu as far as Puerto Mairo. He originally settled at Puerto Mairo but moved from there because of the terrific storms experienced in that neighborhood. At Puerto Mairo he traded with the people of Pozuzo and exported his produce to Lima. At Puerto Victoria he conducts all his trade with Iquitos.

No one now lives at Puerto Mairo except a Chinaman and his old mother; but there is a considerable population of Indians in the neighborhood, some of whom grow cotton which they sell to Sr. Buttgenbach. The Indians belong to three distinct tribes. In the Pozuzo-Puerto Victoria area live the Ammashes. They are partly civilized and are not particularly hardy. To the east of Puerto Victoria live the Campas, a virile race, not so much touched by civilization. In the Pampas de Sacramento to the northwest live the Cashivos, completely untouched by civilization. Sr. Buttgenbach has two or three Cashivo children working on the *hacienda* at Puerto Victoria. These children, found as small babies deserted in the forest, are pretty and intelligent.

FIG. 43—Working the radio set at Puerto Victoria.

Everything at Puerto Victoria grows with great rapidity. Yucas in six months sometimes grow single roots twenty-five pounds in weight. Sr. Buttgenbach was experimenting with the growing of ginger for export to Europe, but so far the crop had not progressed sufficiently for him to know whether it would be successful.

Sr. Buttgenbach's uncle, Herr Kurt Buttgenbach, formerly the editor of a German newspaper in Aachen and now living with his nephew, has been taking systematic meteorological observations here. Some of his records for 1925–1926 are published in Table I.

Puerto Victoria was as far east as we intended to go, and we returned to Lima by the way we had come, no further work being practical owing to sickness amongst the party and the approach of the rainy season.

Table I—Meteorological Observations at Puerto Victoria, 1925–1926

	Temperature °C.								Rainfall in Millimeters			
	Mean Monthly			Absolute		Daily Range			Daily Mean		Most in a Day	Total
	Mean	Max.	Min.	Max.	Min.	Mean	Max.	Min.	5.30 P.M. to 6.30 A.M.	6.30 A.M. to 5.30 P.M.		
1925												
Nov.	26	29.6	23.4	32	22	5.1	8.5	2.0	7	3.2	84	306
Dec.	26.5	29.1	23.8	32	22.5	4.2	8.5	0.5	2.5	3.5	92	186
1926												
Jan.	26.9	29.8	24.1	32	21	6.1	9.0	4.0	2.5	2.0	30	139
Feb.	26.6	29.4	23.8	33	21	5.6	10.0	1.5	2.3	1.9	24	117
March	26.6	29.0	24.1	31.5	21	5.1	10.5	0.5	5	3.5	83	266
April	26.6	29.0	24.8	31.5	21	5.0	7.5	2.0	1.5	0.2	14	50
May	25.6	28.0	23.2	32	20.5	4.8	8.0	2.0	1.6	0.1	24	53
June	26.2	29.1	23.3	31.5	21	5.8	9.0	1.5	2.7	0.3	34	92
July	26.2	28.8	23.6	31	18	5.2	10.0	3.5	0.9	0.3	10	35
Aug.	26.4	30.1	22.7	33	21	7.4	10.5	0.0	0.1	0.3	7	14
Sept.	27.9	32.2	23.6	34.5	21	8.6	11.0	0.5	0.7	1	21	52
Oct.	26.8	29.7	23.8	34	19.5	5.9	12.4	0.5	2.1	1.5	37	110
Nov.	26.1	28.2	23.9	31.5	21	4.3	8.0	0.5	6.7	4.7	82	342
Dec.	25.6	27.6	23.6	31	22	4.0	8.0	1.0	6.1	8.8	143	481

The Physiography of Central Peru

The principal physiographic features of Central Peru may be understood by reviewing the photographs that illustrate the preceding narrative. Long-continued erosion upon complicated rock structures produced in times past a surface of little relief (Figs. 4–5). Parts of this surface are still well preserved with only moderate erosion following soil stripping (Fig. 4). Other parts are more deeply dissected (Fig. 5). A feature commonly found in the Central Andes—local alluvial fill merging into erosional surfaces in the intermontane areas—is well shown in Figures 6 and 7. The relation of the higher residual elements of the landscape to the lower and flatter elements of fill and erosion surface is most clearly shown in the contrast afforded by Figures 6 and 13 taken from the same station. The long lateral moraine that shows in the latter photograph marks the site of a huge glacier that descended from the high cordillera that here forms the Atlantic-Pacific divide. Glacial forms are among the most distinctive in the whole field of our survey. They are brought together and their relations to high mountain country and drainage lines shown upon the map, Plate I. Their detailed expression is best seen in Figures 12, 16, 17, 19, 24, 25. Moraines and U-shaped valleys with characteristic lakes, steep-walled cirques, hanging valleys, and other topographic discordances are abundant and are all disposed in natural relationship to the living glaciers of today that occupy the remoter mountain strongholds.

Upon the main valley floors, and below the scenes of active glacial scouring, are deposited the waste products delivered to the streams in the glacial period. Figure 35 shows this feature, and the pencil sketches illustrate other phases of it (Figs. 30–32). With the waning of the glaciers, and probably as a further result of recent uplift, the alluvial fill has been deeply eroded and in part reworked. The process is going on rapidly today. The alluvial forms are of special geographical interest because of the disposition of fields and pastures in conformity with them (Figs. 29 and 32). Toward the eastern border of the Andes the forms developed upon the fill, as well as glacial forms and pampa flats, give way to those associated with vigorous erosion under a heavy tropical rainfall with turbulent streams and steep mountain slopes marking the transition to lower valleys and plains.

APPENDIX: THE SURVEYING AND ASTRONOMICAL WORK

The surveying instruments had been selected with regard to lightness of weight, as it was expected that this work would be done by only one man. The instruments are illustrated in Figure 46, and their weights are given in Table III.

The Wild theodolite was used for all the trigonometrical and astronomical work and proved very satisfactory. Unfortunately at one period the vertical circle went out of action, owing to a defect in one of the prisms, and had to be dismantled and reassembled in the field. This took considerable time; but, considering the reputedly complicated optical arrangement, it is remarkable that it was possible to get the instrument back into good working order again.

At Cerro de Pasco and Goyllarisquisga we used the Cerro de Pasco Company's triangulation stations and several of our own. The former were permanently marked by lengths of iron tubing stuck vertically into concrete. Datum level was taken from the Cerro de Pasco Company's bench mark at Cerro de Pasco station. A list of geographical coördinates and heights above sea level of the principal points fixed trigonometrically is given in Table III.

Most of the peaks in the above list may be identified in the line drawings (see Fig. 44). Peak No. 1 is a conspicuous Matterhorn type of peak to the southwest of Lake Punrún. Peak No. 2 overlooks the upper Jumashi Valley and stands to the west of it in the main cordillera. Peak No. 3 stands at the head of the Colpa Grande River. Peak No. 4 is a dome-shaped black peak on the Pacific side of the main cordillera close to the Anamaray Pass. Peak No. 23, as seen from Cerro de Pasco, appears as a curious-shaped knob, not very high, on the distant north horizon. Peak No. 24 is an isolated mountain to the north. Peak No. 25 is one of the last snow-capped peaks to the northeast of Cerro de Pasco. It is the highest and most conspicuous peak in this direction. Peak No. 34 is the most conspicuous peak as seen from Cerro de Pasco to the south of Peak No. 1 in the main cordillera. Station No. 1 at Cerro de Pasco is a temporary station on a hill to the northeast of the town. It was not permanently marked. Stations 2 and 3 were triangulation stations in the Cerro de Pasco Company's own survey. At Goyallisquisga, Stations 38 and 39 were Stations G1 and M2 in the Company's triangulation at this latter place.

The astronomical station at Huánuco was in the back courtyard of the Hotel Inca. The station at Tambo de Vaca was on the main trail where a small trail from

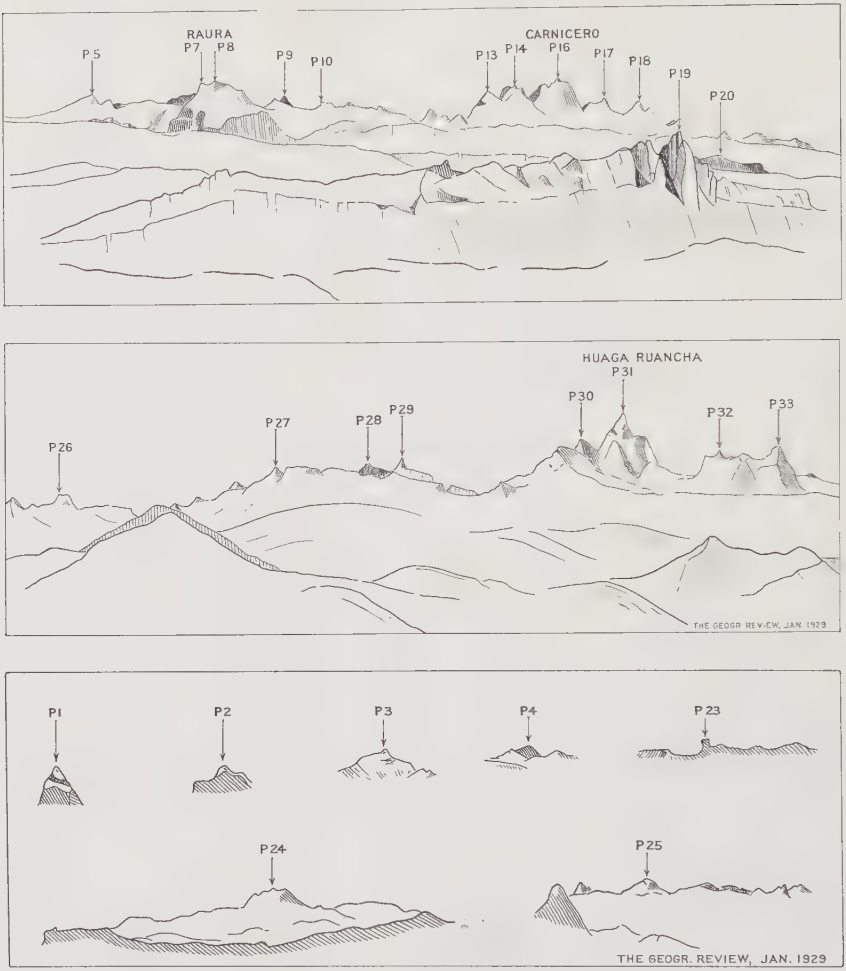

FIG. 44—Sketches from Station No. 1, Cerro de Pasco. The top panel is looking northwest; the middle, looking east; the bottom panel is for the identification of individual peaks.

the northeast joins it. The station at Cushi was 200 feet to the east of Sr. Ballesteros' *hacienda.* The station at Pozuzo was in front of the church. The station at Puerto Victoria was about 100 yards south of Sr. Buttgenbach's *hacienda.*

It was difficult to know what coefficient of refraction to take at the high altitude we were working in: the figure eventually adopted was 0.050, which gave quite satisfactory results. The checks on the work at Goyallisquisga were sufficiently good, considering that the intersections were made on the tops of unbeaconed peaks. The astronomical method employed for determining latitude and longitude was the Marc St. Hilaire method as adapted by John Ball for precise work on land. The observing for this method requires that the Greenwich time of observation be known very exactly, and this was possible as wireless time signals were received from Arlington a few hours before and after each set of observations. The latter consisted of a series of time and altitude observations taken on four or more stars of widely varying azimuths, at least four observations taken on each star. This method has many advantages over most of the other methods generally used in the field. Any star at

TABLE II—GEOGRAPHICAL COÖRDINATES AND HEIGHTS ABOVE SEA LEVEL OF SURVEY-CONTROL POINTS

NAME OR NUMBER OF STATION	LATITUDE SOUTH	LONGITUDE WEST	HEIGHT ABOVE SEA LEVEL	
			FEET	METERS
No. 1 (at Cerro de Pasco)	10° 39′ 05″	76° 15′ 08″	15,074	4594
No. 2 (at Cerro de Pasco)	10° 41′ 16″	76° 16′ 29″	14,285	4354
No. 3 (at Cerro de Pasco)	10° 41′ 33″	76° 15′ 15″	14,726	4488
(S. E. Corner chimney C. de P. Co.'s office, Cerro de Pasco)	10° 41′ 12″	76° 15′ 34″	14,261	4346
Peak No. 1	10° 55′ 52″	76° 36′ 13″	17,756	5412
Peak No. 2	10° 44′ 57″	76° 36′ 13″	17,683	5390
Peak No. 3	10° 40′ 37″	76° 40′ 07″	17,572	5356
Peak No. 4	10° 34′ 50″	76° 43′ 33″	17,157	5229
Peak No. 5	10° 31′ 18″	76° 42′ 50″	17,535	5345
Peak No. 7 S. E. Peak Raura	10° 29′ 21″	76° 43′ 00″	18,570	5660
Peak No. 8 N. W. Peak Raura	10° 29′ 05″	76° 43′ 11″	18,755	5717
Peak No. 9	10° 26′ 30″	76° 46′ 59″	18,336	5589
Peak No. 10	10° 26′ 10″	76° 45′ 39″	18,173	5539
Peak No. 13	10° 18′ 08″	76° 53′ 32″	20,156	6143
Peak No. 14	10° 17′ 45″	76° 52′ 59″	20,839	6352
Peak No. 16 (Carnicero)	10° 16′ 01″	76° 54′ 09″	21,760	6632
Peak No. 17	10° 15′ 00″	76° 54′ 02″	20,090	6123
Peak No. 18	10° 14′ 06″	76° 54′ 08″	20,104	6128
Peak No. 19	10° 37′ 39″	76° 17′ 17″	15,118	4608
Peak No. 20	10° 33′ 08″	76° 23′ 40″	14,927	4550
Peak No. 23	10° 12′ 24″	76° 30′ 20″	14,669	4471
Peak No. 24	10° 11′ 23″	76° 24′ 21″	15,960	4865
Peak No. 25	10° 02′ 49″	75° 59′ 12″	16,732	5100
Peak No. 26	10° 22′ 47″	75° 57′ 34″	16,757	5107
Peak No. 28	10° 30′ 27″	76° 00′ 15″	16,562	5048
Peak No. 29	10° 28′ 43″	75° 56′ 25″	17,056	5199
Peak No. 30	10° 31′ 38″	75° 56′ 30″	17,856	5442
Peak No. 31 (Huagaruancha)	10° 31′ 46″	75° 55′ 44″	18,797	5748
Peak No. 32	10° 33′ 07″	75° 56′ 16″	16,804	5122
Peak No. 33	10° 33′ 53″	75° 56′ 21″	16,930	5160
Peak No. 34	11° 08′ 54″	76° 30′ 03″	17,616	5369
Station No. 38 (at Goyllarisquisga)	10° 28′ 04″	76° 24′ 22″	13,955	4253
Station No. 39 (at Goyllarisquisga)	10° 29′ 22″	76° 24′ 45″	13,984	4262
Huánuco	9° 55′ 27″	76° 14′ 12″	(6,397)	(1950)*
Tambo de Vaca	9° 52′ 03″	75° 45′ 37.5″	(11,384)	(3470)
Cushi	9° 58′ 27″	75° 41′ 40″	(6,233)	(1900)
Pozuzo	10° 03′ 42″	75° 32′ 43″	(2,789)	(850)
Puerto Victoria	9° 53′ 23″	74° 56′ 27″	(984)	(300)

*Figures in parentheses indicate approximate heights.

any altitude can be observed and, whether identified or not at the time, can be used later. Consequently, if observing conditions are bad and it is possible to get only occasional glimpses of stars, useful observations are still possible.

It is not necessary to have the theodolite in perfect adjustment for vertical collimation. It is not even necessary to know the collimation error, as this is determined automatically by the computations later. It is not necessary then to change face on the instrument while observing, and consequently a series of observations on one star can be taken very rapidly. The writer averaged just over a minute in the time he took to make and record a single observation.

Comparing it with the equal-altitude method, it must be admitted that each single observation of altitude on a star is probably more accurate by the equal-altitude method; but at least four, generally six, observations are taken on each star by the Marc St. Hilaire method; and in this way personal error is more or less eliminated, and not so many stars need be observed to obtain the required accuracy. No star lists are necessary. It is not necessary to carry mercury to provide an artificial horizon. Fewer stars observed means less computation. No program of work is necessary.

An example of this method is shown and, in the writer's opinion, is convincing proof of its efficacy. The station was over 11,000 feet high. There had been very heavy rain for two days. The mist cleared off for a short time only. In that time, 45 minutes, five stars were observed, at least four altitudes on each star being taken. It clouded over immediately afterwards, and further observation was impossible; but, as will be seen from the diagram of the plotted position lines, all the required precision was obtained, the probable error being about 0.6″ of arc. I do not think that on many occasions this degree of accuracy has been obtained in such a short time and with such light instruments.

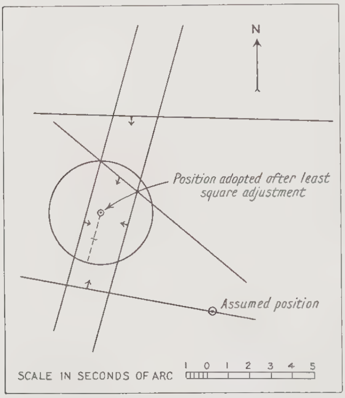

FIG. 45—Diagram illustrating accuracy of astronomical method. The observations were taken at Tambo de Vaca on November 9–10, 1927. The probable error in the adopted position is 0.6″ of arc.

The reception of the time signals was one of the important results of the expedition. It was amply demonstrated that there should be no difficulty in the future in sending small parties out to determine longitude and that there is no longer any necessity of carrying heavy equipment or employing radio experts on expeditions of this nature. The wireless instrument, which weighed only twenty-five pounds, was a long-wave receiving set, constructed for the expedition by the "Radio Broadcast" Research Laboratory, being the fourth constructed by them for the American Geographical Society. The first was successfully used by Mr. Reeves in Venezuela, the second by Mr. Weld Arnold in Gautemala, and the third by the Putnam Baffin Island Expedition. However, such is the rapid improvement in radio construction that, at the moment of writing, it is possible to get a short-wave receiving set which will pick up time signals from all over the world and which weighs, including batteries, about twelve pounds.

With the long-wave set there was at first some difficulty in getting time signals from Arlington; but, by what seemed to be unscientific manipulation of the lead to the ear phones and the lead to the aerial, we were eventually able to get these time signals where and when we wanted. The manipulation consisted in having a loose length of the lead to the aerial bunched up in one hand and bringing it into close contact with the lead to the ear phones.

The watches behaved well. They had small carrying rates most of the time, which was due in part to the method of carrying. Each watch was enclosed in a chamois leather pouch which in turn was shoved tightly into a leather pouch. This prevented a great deal of unnecessary shaking. The pouches were always carried on the belt.

To avoid the trouble of having to mount plane table sheets in the field, the system developed by the writer in 1924 at the School of Surveying of the American Geographical Society was used. This consists of a plane table framework which can be screwed down onto a Johnson plane table movement tripod head. Six specially prepared sheets of very thin aluminum on which good quality drawing paper had been mounted were carried in wax paper envelops. To set up the plane table for use the framework is screwed onto the tripod head, and one of the aluminum sheets is then fixed onto the framework by means of specially constructed thumbscrews which do not protrude above the surface of the paper.

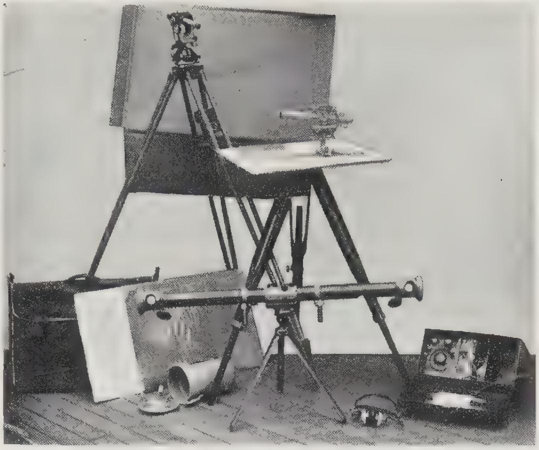

FIG. 46—The surveying equipment of the expedition. Compare Table III.

The range finder was a novelty in the way of instruments which proved very useful, solving the problem of locating points difficult of approach which could be seen from one station only, and doing away with the necessity of a stadia rod and rodman. The Barr & Stroud instrument has been very sturdily built as it is designed for use in warfare. This in itself is an advantage, but for surveying purposes the writer considers that it would be advantageous to have the adjusting screws that correct the halving and centering errors more easily accessible and more sensitive. It was always difficult to keep the instrument in adjustment, but this trouble was overcome by the following process. The distance between the observer's station and any point as determined by the range finder was corrected by comparison between the distances determined from an already fixed point as obtained from the plane table and as read by the range finder. A small sliding scale of tangents was constructed which greatly facilitated this process.

TABLE III—SURVEY INSTRUMENTS CARRIED BY THE EXPEDITION WITH THEIR WEIGHTS

1 Wild theodolite and tripod	26 lbs.
1 wireless receiving set, including batteries	25 "
Watches—1 Ditisheim 1 Zenith 1 Leroy 1 North stop watch 1 Huguenin stop watch	4 "
1 plane table tripod with Johnson movement head	10 "
1 aluminum plane table framework 24″ x 18″ (American Geographical Society model) 6 plane table sheets mounted on aluminum enclosed in oiled paper envelops (the whole complete in canvas case)	16 "
1 Kern telescopic alidade in leather case	12½ lbs.
1 Barr & Stroud range finder	16 "
1 steel tape, 100 meters	5 "
1 Gurley geologist's compass and Jacob's staff	4 "
1 Brunton compass and clinometer	1 "
2 aneroid barometers	3 "
Thermometers	1½ "
Record books, mathematical tables, textbooks, miscellaneous stationery, and drawing materials	22 "
Total weight	146 "

THE INDIAN COUNTRY OF SOUTHERN ARIZONA

J. W. Hoover

Tempe State Teachers College

IN Arizona, as in no other of our states, the Indian has maintained his hold upon the land. In numbers of pure-blooded Indians the state leads with over 46,000 of the nation's 355,000,[1] while over considerable parts of the area primitive cultures hold sway. The white population has infiltered itself into the region on a pattern largely indicative of the areas and zones originally unoccupied or of sparsest Indian population. Only the barren desert wastes immediately to the east of the lower Colorado River have been shunned by both Indian and white. Phoenix, the present metropolis, with the great oasis lying about it is contiguous with the relatively closely knit Pima communities but occupies the lands upon which the Indians were unable to apply water. Tucson, the second largest city and earlier metropolis, occupied a zone between Papagos and Apaches—a part of the Papago territory untenable on account of Apache raids. In northern Arizona the important settlements have grown up along the Santa Fe Railway which succeeded the old Santa Fe trail, proceeding in part through a neutral zone between hostile Apaches to the south and Navajos to the north.

The Indian population of Arizona remains distributed much as it was before white settlement. The present day reservations include the most important areas of Indian occupation, though considerably restricted, especially in the case of the hostile Apaches and Mojave Apaches. For convenience of treatment the Indians of Arizona may be divided into two groups: the southern tribes who occupy the drainage basin of the lower Colorado River and chiefly that of its one important branch, the Gila, and the northern tribes who occupy the drainage basin of the middle Colorado and its chief branch, the Little Colorado. This article aims to give a sketch of the southern group of tribes.

PIMERÍA, LAND OF THE PIMAS AND PAPAGOS

The name "Pimería" was applied by the Spaniards to the territory occupied by the Pima and Papago Indians, that part which is now in Arizona being called Pimería Alta in distinction to the Papago country of Sonora, Mexico, Pimería Baja. The Arizona Pimería, so designated, is nearly coincident with the physiographic division known as the Basin Range Province, excluding the lands adjacent to the Colorado River and the unoccupied desert between the Colorado and the Gila rivers.

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[1] If mixed-blood Indians are included, Oklahoma leads with some 120,000; but, whereas the Indian population of Oklahoma is only 29 per cent pure Indian, that of Arizona is almost 99 per cent pure. New Mexico ranks third in both full-blood and in total Indian population (Extracts from the *Ann. Rept. of the Secretary of the Interior relating to the Bur. of Indian Affairs*, 1927). Compare H. J. Spinden: The Population of Ancient America, *Geogr. Rev.*, Vol. 18, 1928, pp. 641–660.

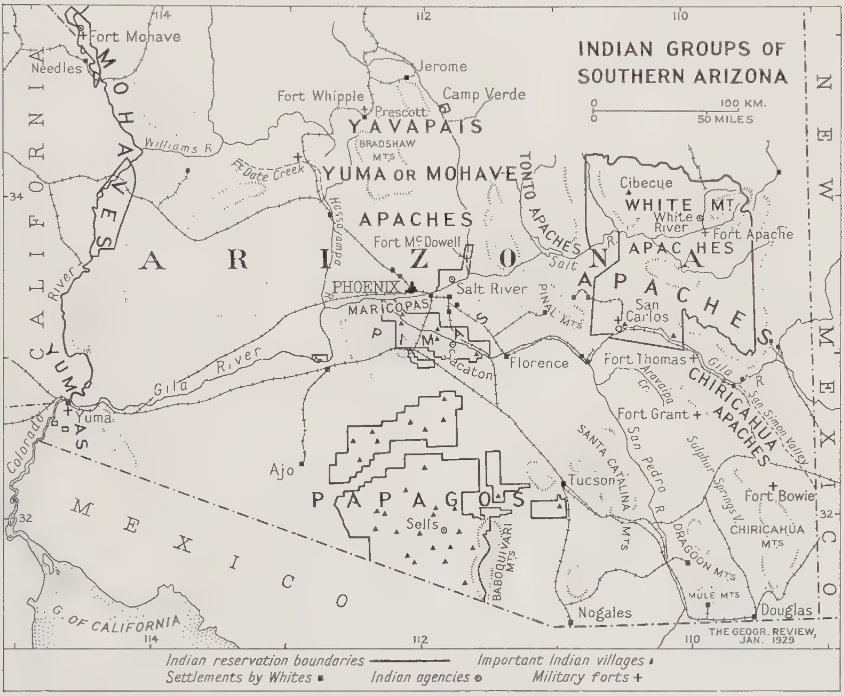

FIG. 1—Map showing the general distribution of the most important Indian groups of southern Arizona. The scale is a little less than 1:5,000,000.

The Pimería is an arid country with well eroded fault block mountains rising between broad waste-filled intermont depressions. In the lower parts of the depressions, farthest from the mountains, sand and gravel washes traverse flat silt lands which have a surface veneer of coarser material. Nearer the mountains the land rises in long gentle alluvial slopes of sandy soil, known as the *bajada* slopes. Still nearer the mountains the bajada becomes gravelly or stony. Finally rock floor is exposed in the washes, revealing the mountain pediment, a subaerial extension of the mountain block protected from denudation. The general axis of surface features is northwest by southeast. The interlacing intermont plains rise imperceptibly from an elevation of several hundred feet in the west to over 2500 feet in the east and northeast. Out of them rise abruptly the low narrow mountain ridges, bare and harsh. In the east the mountains are most massive and elevated, reaching the greatest height in the Baboquivari Range and its peak with an elevation of 7741 feet.

The outstanding climatic facts of the Pimería are the low and erratic rainfall, averaging about ten inches on the inhabited plains, accompanied by a very high rate of evaporation; the extremely high summer temperatures, very frequently rising above 100° F., and mild winters with temperatures seldom below freezing except in the higher parts; the marked daily range, often over 30° or even 40° F.; and the high percentage of sunny days averaging from 320 to 350 for the year.[2] In other words, the region has a desertic type of climate.

In the west the Pimería is truly a desert, but farther east with more rainfall the vegetal aspect is rather steppelike. The vegetation is nevertheless highly xerophytic and is characterized by peculiar and striking forms.

The Pimas and Papagos who occupy the Pimería are about equal in numbers; but the Pimas, having occupied the best lands on the flats along the Gila and Salt rivers near the present city of Phoenix, have required only a fraction of the area that has been required for the support of the Papago population.

The Pimas were able to divert water from the rivers upon the flood plains and became definitely settled as agricultural village dwellers. Their situation on the northern border of the Pimería exposed them to the raids of their mountain neighbors. Constant danger prevented them from scattering, and under pressure of necessity they became valiant warriors. They performed invaluable services to the whites during the turbulent periods of the Apache wars, furnishing protection to the pioneers and supplies to travelers. "Their regular fields, well-made irrigating ditches, and beautiful crops of cotton, wheat, corn, pumpkins, melons and beans, have not only gladdened the eye, but also given timely assistance to the emigrants who have traversed Arizona on their way to the Pacific."[3]

With fairly certain crops, the Pimas never learned to provide for lean years as did their kinsmen of the south who led a more precarious existence. The Papagos are more industrious and are much preferred as laborers to the Pimas. They are more ready to seek remunerative employment than the Pimas, although much more remote from sources of employment. Until about 25 years ago, the Pimas allowed the Papagos to come to their villages and thresh their wheat for a share. The practice is still carried on to a certain extent.

The area occupied by the Pimas, mostly in the Gila River Reservation, extending about fifty miles along the river, possesses natural advantages which have from remote times made it a focal area for agricultural peoples. When first known by the whites, more than two hundred years ago, the Pimas had already occupied these lands at least several hundred years. For seventy miles along the Gila as well as along the Salt River are scattered the remains of the culture of a people much older and farther advanced. The land of the Pimas, including the Salt River plain, has in the past supported denser populations than any other part of Arizona.[4] This is true today of the Salt River plain and would be true also of these lands along the Gila had they been given equal opportunity of development. The Indian population was here dense enough to maintain its hold upon lands coveted by the whites.

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[2] See, for example, the meteorological summary for Sacaton in C. J. King and A. R. Leding: Agricultural Investigations at the United States Field Station, Sacaton, Ariz., 1922, 1923, and 1924, *U. S. Dept. of Agric. Dept. Circular No. 372*, June, 1926.

[3] Sylvester Mowry: Arizona and Sonora, *Journ. Amer. Geogr. and Statist. Soc.*, Vol. 1, 1859, pp. 66–75; reference on p. 70.

The several hundred Pimas who live on the north side of the Salt River settled there at the suggestion of white settlers around Tempe, who sought thus to place a buffer between themselves and the Apaches. Later these same people requested the government to return the Indians to the Gila Reservation; but the request was denied, and their lands were designated as the Salt River Reservation.

A third branch of the Pima family, the Sobaipurai, in early Spanish times occupied the Santa Cruz Valley and even the San Pedro Valley to the northeast on the other side of the Santa Catalina Mountains. As far as we know, they are to be distinguished from the Pimas and Papagos only geographically. Later they were driven westward by the Apaches, and it is supposed their remnants joined the Pimas and were absorbed by them.

The Gila River and Its Changed Character

The Gila River leaves the mountains to enter upon the detrital plains of the Basin Range Province about ten miles east of the city of Florence. Throughout its lower course it has incised a very shallow valley into the detrital plain. It is here a braided stream occupying a strip from a quarter of a mile to nearly a mile in width: the whole of its channel or any considerable part of it is occupied only occasionally after heavy rains. The channel is pretty well filled with shifting sandy deposits where only clumps of arrow weeds and low shrubs manage to get a hold here and there.

The Gila has changed greatly in character within the last half century. Old settlers are united in describing the Gila of fifty years ago as without shifting braided channels. Cottonwood, brush, tall grass, and weeds bordered the river, which was confined to a narrow channel. In the fall of 1849 a family and two other men floated down

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[4] Walter Hough: Antiquities of the Upper Gila and Salt River Valleys, *Bur. of Amer. Ethnology, Bull. 35*, 1907.

Frank Russell: The Pima Indians, *26th Ann. Rept. Bur. of Amer. Ethnology for 1904–1905.*

Omar A. Turney: The Land of the Stone Hoe, Phoenix; see especially pp. 5–28.

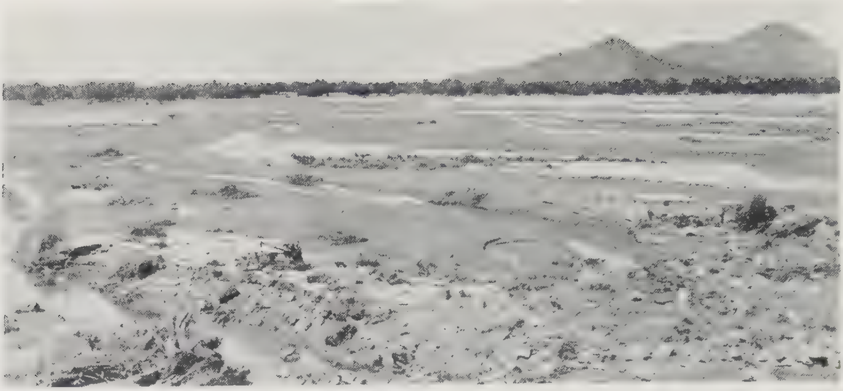

FIG. 2

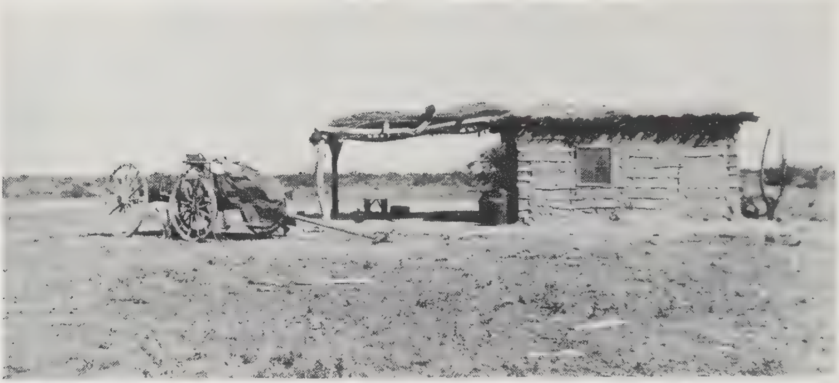

FIG. 3

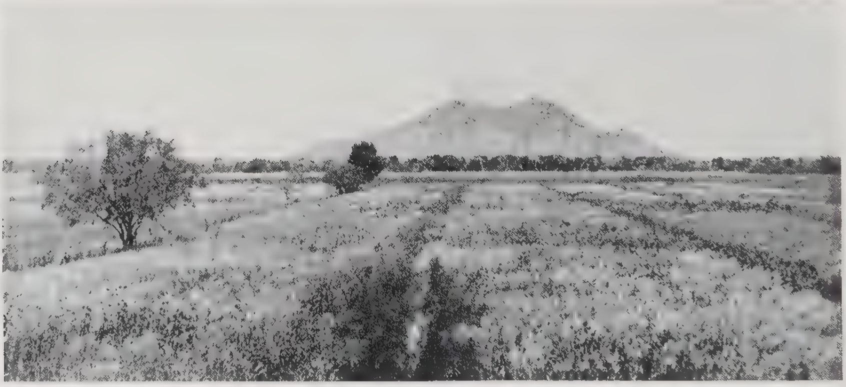

FIG. 4

FIG. 2—Gila River, looking northwest from the Sacaton bridge.

FIG. 3—Typical Pima home evolved from the primitive "ki." The arbor, which was formerly placed somewhere near the "ki," has here become an adjunct of the house.

FIG. 4—View from terrace over Pima grainfields. In the background are the cottonwoods of the bottoms, and Gila Butte is seen on the other side of the river.

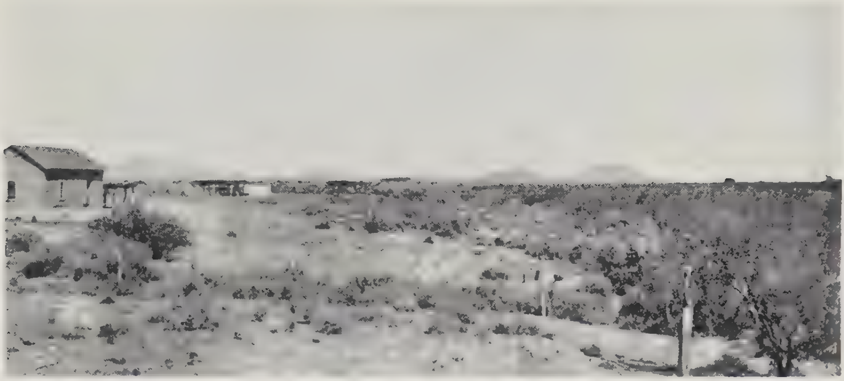

FIG. 5

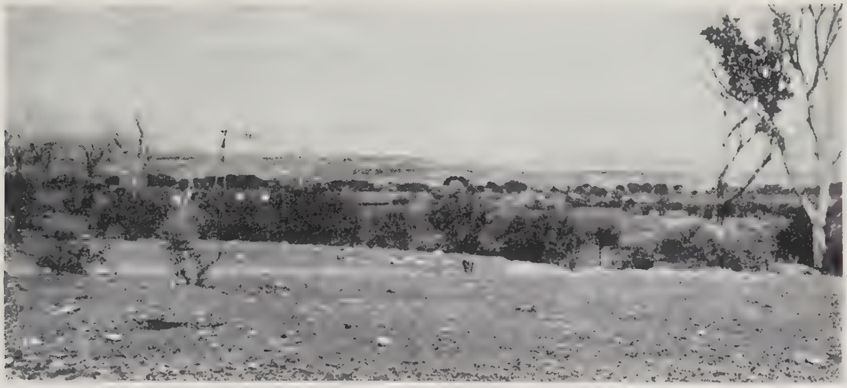

FIG. 6

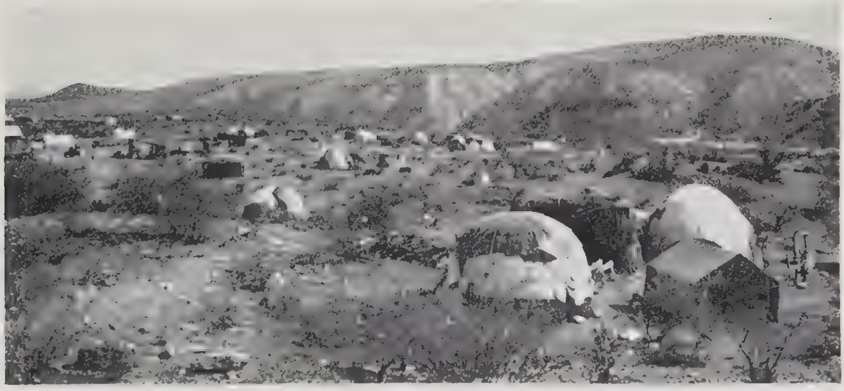

FIG. 7

FIG. 5—The upper terrace at Snaketown. Note the settlements on the upper terrace and the change in vegetation—salt bushes above and mesquite below.

FIG. 6—Terraces of the Gila River as seen from San Carlos, Apache Indian Reservation.

FIG. 7—Apache Indian village, near the Coolidge Dam site, San Carlos Indian Reservation.

the Gila from the Pima villages to the Colorado River on a flatboat 16 feet long and 5½ feet wide.[5] This was the period when river boats sailed from the Gulf of California through the delta and up the Colorado River. The channels of the delta of the Colorado have long since silted beyond possibility of navigation;[6] and the Gila, if not dry or very low, is in flood with current too swift for boats.

There is little similarity between the river of these descriptions and that of today; yet that portion of the Gila below the railway bridge at Pima Butte is perennial, and the waters except when high are clear. The perennial flow of the river here is primarily due to underground drainage deflected from the Salt River.[7] There is also some extra seepage from the Roosevelt irrigation project.

According to the old Indians on the reservation the river used to be everywhere constant, always supplying plentiful water for irrigation. Only in occasional very dry years did it cease to flow, and then large pools remained in the bed. Little distress was felt by the Pimas even in such years; but the Papagos to the south, whose water supply was less dependable, would then seek relief from the Pimas. As late as the seventies, and even during the eighties, the river occupied a narrow channel and its bed was covered with large stones. There were no such stretches of bare and sandy waste as are found everywhere along the river now. Tall grass, sometimes several feet high, covered the whole countryside yearly. But the once grassy swales are now for the most part salt bush steppe or desert. Lakes or ponds were once common over the river flats where there is no trace of them today.

The changes in the character of the Gila have reduced the Pimas of the middle and upper parts of the reservation to a system of agriculture relying upon the irregular flood waters for irrigation. Their circumstances have been particularly trying during the late few years of drought. At the lower end of the reservation there is always water in the river, and there is no real want; but the floods wash out the dams and make diversion more difficult. However, whether there shall be water on the fields or not is chiefly a matter of industry.

The widening of the river channel still goes on. At Snaketown, north of the river near the center of the reservation, the river is rapidly cutting away land that has been under cultivation and that lies on the terrace. Near the pumping station on the north side of the river 7½ miles east of Snaketown, the river cut sixty feet into the terrace the winter before last. In the upper Gila Valley, plane table survey indicated that from October, 1915 to September, 1916 the Gila River washed away a total of 990 fertile acres in the San Carlos Apache Indian Reservation and 1155 acres of lands higher up in the Safford Valley. In October, 1917, 400 more acres were washed out in the Safford Valley.

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[5] H. H. Bancroft: Arizona and New Mexico, 1530–1888 (History of the Pacific States of North America, Vol. 12), San Francisco, 1888, p. 487. See also C. P. Ross: The Lower Gila Region, Arizona: A Geographic, Geologic, and Hydrologic Reconnaissance With a Guide to Desert Watering Places, *U. S. Geol. Survey Water-Supply Paper 498*, Washington, 1923.

[6] Godfrey Sykes: The Delta and Estuary of the Colorado River, *Geogr. Rev.*, Vol. 16, 1926, pp. 232–255.

[7] W. T. Lee: Underground Waters of Salt River Valley, *U. S. Geol. Survey Water-Supply Paper 136*, Washington, 1905; reference on pp. 123–125.

The changed behavior of the Gila is generally attributed to overgrazing in the Upper Basin. Before 1870 there were few cattle, but they increased rapidly after the settlement of the Apache Indian troubles that year. During the eighties there was a series of wet years with abundance of natural forage. The ranges built up rapidly, and overgrazing resulted. During the same period the mountains of the Upper Basin in southeastern Arizona were being rapidly stripped of their timber for use in the mines. The hills were barer than now, because with the advent of the railways better mine timber was brought in from the outside; but the cutting for fuel continued. At the end of this series of wet years came the disastrous flood of 1891. Before this, flood waters of the Gila merely spread out over the flats and irrigated them. Now with the banks of the river unprotected by brush and grass, the channel suddenly widened, and many good ranches along the river were cut out. Smaller branches of the river in the upper basin cut channels as much as twelve feet deep. On the desert deep channels appeared in what had been grassy swales.

On the other hand, Bryan[8] calls attention to the fact that such channel cutting has been general throughout the southwest and began as early as the sixties. He, with others, is favorably inclined toward Huntington's hypothesis of a slight change of climate toward drier conditions as decreasing the vegetation cover and promoting run-off with more rapid erosion. The erosive work of the flood of 1891 was greater than that of all the previous years of settlement in the basin; a reduced vegetation cover greatly aggravated erosion. The reservation area has suffered less than the lands above, partly because of the low relief of the plain, but also no doubt because there has been less cultural disturbance here. The only important recent topographic change has been the silting up of the river channel and consequent widening.

In addition to such possible general causes of change was the reduction of water on the lower Gila due to irrigation farther up the river. Serious deprivation of water on the reservation began with diversion in the Florence district immediately above the reservation. It began in the sixties and reached its climax in the eighties. The Florence district was in turn deprived of most of its water by diversion in the upper Gila Valley.

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[8] Kirk Bryan: Date of Channel Trenching (Arroyo Cutting) in the Arid Southwest, *Science*, Vol. 62, 1925, pp. 338–344.

THE TERRACES OF THE GILA RIVER IN RELATION TO PIMA CULTURE

The sides of a well developed valley flat in the alluvial plain along the Gila are marked by terraces varying in height up to about twenty feet on the Gila River Reservation. The terrace is best defined on the north side of the river below Gila Butte and vanishes entirely east of Gila Butte and around Sacaton. The flood plain reaches its greatest width of four miles between Casa Blanca and Snaketown, and the main river channel is nearly three miles from Casa Blanca.

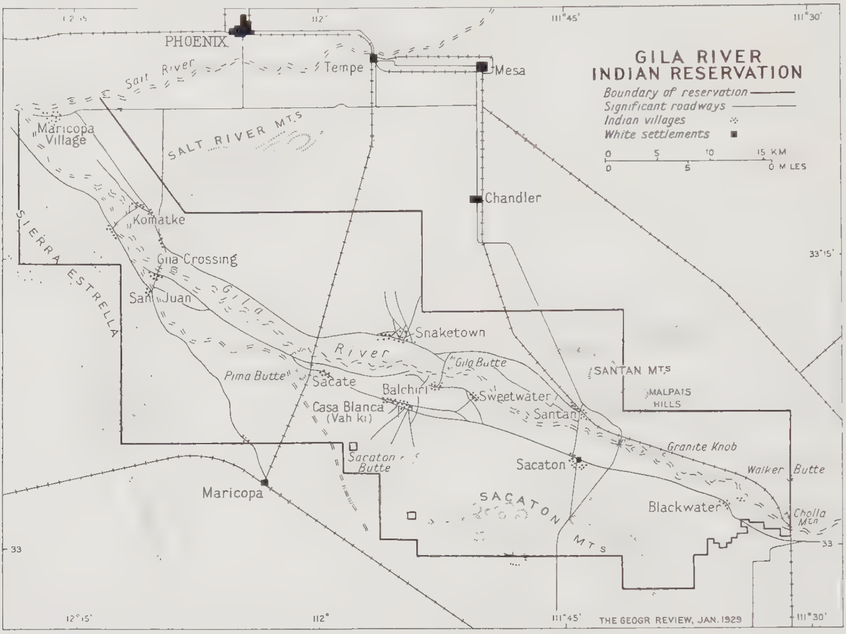

FIG. 8—Map of the Gila River Reservation. Scale approximately 1:750,000.

Within this flood plain the river has cut an inner flat which confines all but the occasional master floods. It is bounded by lower terraces from three to ten feet in height. Over this flood plain the channel of the river varies considerably from time to time. For convenience we may speak of this low land bordering the river as the bottom land, the land on the outer flood plain as the lower terrace, and that above as the upper terrace.

The correlations of soil, vegetation, and culture are striking. The lands on the upper terrace are sandy with a veneer of gravel, while gray salt bushes mark it off distinctly from the bright green feathery foliage of the mesquite thickets so characteristic of the lower terrace where not cultivated. On the lower terrace the soil is silt and usually heavy. The bottom lands are sandy with an abundant mixture of silt. Cottonwood groves and arrow weed, a tall slender reed, characterize the vegetation. Where the river is more stable or the ground is higher, the mesquite and salt bushes encroach upon the bottoms; but the cottonwoods and arrow weeds stop abruptly at the lower terrace, except that, wherever the lands are cultivated, cottonwoods take hold.

The cultural features of the reservation are as strikingly arranged with reference to the terraces as is the vegetation. Although the terraces are not indicated on the topographic maps of the Geological Survey, they can be traced fairly accurately by the cultural features as indicated.

The cultivated lands are limited strictly to the lower terrace, or terraces, where there is a further division of the terraces as at the villages Balchirl, Sweetwater, and Santan. The land under cultivation is further limited with reference to the possibility and ease of getting water on it. The villages are mostly located on the edge of the upper terrace overlooking the irrigable lands on the lower terrace. Up the river from Sacaton the upper terrace is not apparent as a topographic feature except for the characteristic vegetation association. Sacaton and Blackwater as well as the small villages between them are not definitely located with reference to terraces; but before white settlement there were no Pima villages in the upper end of the reservation. Sacaton itself was not an Indian village to begin with but developed around the government school.

The villages of the prehistoric people who occupied the area were distributed similarly to the villages of today. On the reservation, the most conspicuous of these ruins is that of the pueblo at Casa Blanca, now weathered into a huge mound. The largest cluster of mounds is directly across the river at Snaketown. The famed Casa Grande Ruin, just off the reservation to the southeast, is in a much better state of preservation. Some of the canals of the Hohokams, as these early people are called by the Pimas, extended onto the upper terrace lands, which they evidently cultivated in part. None of the upper terrace lands have been reclaimed by the Pimas; the ancient population was probably denser and certainly more advanced in technique and social organization. The river may also have been at a slightly higher level than now.

A main traveled road connects the villages all the way along each side of the river, following quite closely the edge of the upper terrace, where it is sandy enough to dry out readily, and is generally smooth. If a spot becomes rough it is simply avoided, and a new track develops around it. Many roads, if such they may be called, radiate from the villages onto the upper terrace lands called the "mesas." On the lower terraces the roads become deep sticky mud after rains; and later this bakes hard and rough, very dusty when dry. Through the cultivated lands they now run in straight lines and at right angles conforming to the plotting of the land allotments by the United States Indian Service. Before the advent of the Southern Pacific Railroad the old transcontinental stage road followed the terrace route through Casa Blanca and Sacate. Wherever the lower terrace is wide and at least partially under cultivation a secondary road generally follows in the main the terrace bluff.

Several reasons suggest themselves for the preferred siting of the villages on the upper terraces. The drainage is better, and there is safety from flood. According to the Indians, the waters of the Gila twice since 1890 rose over the lower terrace and covered it to Casa Blanca. Communication has always been easier along the upper terrace, and better protection was afforded against hostile attack as here the enemy could be sighted from afar. The low mesquite thickets near the river were certainly much less desirable for homes than the open upper terrace. Casa Blanca and Snaketown have especially attractive sites with unobstructed outlook for miles in every direction. The Indians may also have discovered that the upper terrace sites were more comfortable, being warmer in winter because the cold air at night drained to the lower levels and cooler in summer because more exposed to the breezes. As time goes on, however, the Indians are scattering more widely over their tilled lands on the lower terrace.

During the middle of the nineteenth century the Pimas were almost entirely concentrated in villages on the south side of the river, owing to the dangers from Apache raids. The Pima settlements then extended from a point about two and a half miles below Sacaton nearly to Pima Butte. Early in the nineteenth century, according to numerous accounts of travelers and explorers and old Indians,[9] they seem to have been more widely spread. With the settlement of the whites along the Gila and Salt rivers and the establishment of peace with the Apaches, the Pimas have again extended their settlements.

Economic Conditions of the Pimas

The chief crops of the Pimas today are, in order of importance, wheat, corn, alfalfa, and cotton. Vegetables, as beans, squash, pumpkins, and melons are also grown. Pima squaw corn is a popular native variety as it flowers in 50 or 60 days after planting, making small demands upon irrigation water. Unless flood water is abundant, it often happens that the heavy irrigation preliminary to planting is all the water that the crop receives.[10] As ordinarily grown by the Indians it rarely produces more than 10 or 15 bushels an acre.

The old Indians had a method of cultivating their grain which the whites have not been able to improve upon under the same conditions. A peculiar method of plowing in the seed left the surface rough and afforded some frost protection. The soil then crumbled with the first irrigation and did not bake. The Pimas divert their water from the river by brush dams, constructed with considerable labor, or sometimes by mere embankments of river sand or silt. There are usually five or more such dams in the river, but they are often washed out by floods. During the several past years the Indians in the middle of the reservation have had to depend largely upon cutting and selling mesquite wood. A man requires two or three days to assemble a load which he may sell for about $6.00. Then he must haul it 15 to 20 miles and peddle it, which takes two more days unless there is a prompt sale. With more plentiful water the Indians leave off wood cutting and go back to their fields. A few of the Indians, especially at Casa Blanca, own some scrub cattle from which they derive partial or entire support.

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[9] Russell, *op. cit.*, p. 20.

[10] C. J. King: Crop Tests at the Cooperative Testing Station, Sacaton, Ariz., *U. S. Dept. of Agric. Dept. Circular 277*, 1923.

After a difficult political struggle, the Federal government in 1924 authorized the construction of a dam on the Gila in the mountain narrows below San Carlos, the object being to restore their waters to the Pimas and to reclaim other lands. Construction was begun some time ago, and water will soon be provided for that part of the reservation above the Arizona Eastern Railroad. With the completion of the project the flood menace will have vanished, and the bottoms will be cultivated. Much of the upper terrace lands will also be brought under irrigation. The Indians will generally move out upon allotments, and the original character and diversity of the landscape will give way to homogeneity of aspect.

The Mohave Indians

The Mohaves in their manner of living are much like the Pimas, being another tribe of oasis dwellers, utilizing the low narrow flood plains of the Colorado River between Needles, Cal., and Yuma where they formerly planted their corn, beans, and squash in the river ooze as the spring floods ebbed. The largest single village is near Needles. The Mohaves have been considerably reduced in numbers, suffering from contact with the worst element of the pioneer whites. Tuberculosis is now making serious inroads upon them.

About 25 Cocopah Indians live similarly to the Mohaves on two tiny reservations within the Yuma Irrigation Project.

The Papago and the Papaguería

Barring a single outbreak in 1871 the Papagos, like the Pimas, have always been friendly to the whites, with whom, however, in their isolated location, they have had much less contact. To the country at large the Papaguería has been a *terra incognita*, a waterless land seldom visited by white men, a forbidding desert taking its toll of human life.[11] The region is becoming better known since the advent of the automobile, the opening up of the mining camp at Ajo with railway connections to the Southern Pacific, and an automobile road now being extended eastward from Ajo and westward from Tucson. Over most of the area the Papagos are still the only inhabitants except for a handful of Indian agents, traders, and teachers. Southward the Papagos and their country continue into Mexico with no definite southern boundary, as the Papago population merges into the Mexican population. The Growler Mountains mark the western limit of their territory, though formerly a few people known as the Arenos or Sand Papagos eked out a meager existence in the barren desert west of this feature.

A very low standard of living prevails among the Papagos; yet, in spite of adverse conditions, they are among the few of our Indians who have remained entirely self-supporting. Hardly any other Indians have had their area so little exploited by other people. Their very poverty has been their protection. Those who know them best speak highly of their virtues and regret that American schooling too often breaks down their racial traditions of virtue and honor.

Today, as always, scarcity of water has been the determinant in the life of the region.[12] The Papagos commonly migrated between two villages, the one located near a permanent water supply found locally around the base of the mountains, the other about their temporals or fields along the washes out on the plains or in the valleys. The practice still continues with many of the Papagos, especially on the western half of the reservation.

The water supply at the temporals, or summer rancherias, was obtained from surface run-off during the summer rains and retained in hollow basins called *charcos* which were made by digging out a depression and applying the earth to an embankment on the lower side. The water supply thus obtained became warm and stagnant and was shared by the animals, yet it had to serve all domestic purposes. Even the water supply at the winter villages was often to be had only by patient digging in the sandy washes on the mountain pediment, and then sometimes attained only drop by drop along a plane of contact between sand and stone till the labor, sometimes of hours, was rewarded by one or two gallons of water. Pumpelly, who traversed the region in the early sixties, describes the experience of a friend who reached such a well at a time when, after a succession of dry seasons, the Indians were dying of thirst. "He found a large number of Indians digging recklessly, far below the surface, and following down the line of contact between sand and rock, in the vain hope of finding a few drops of water. In their despair, they undermined the high face of the sand, and it fell, burying for ever a number of the unfortunate creatures."[13] Every drop of water was carefully conserved, even to the drippings from the olla, or earthen water jar, which might grow a couple of onions.

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[11] Compare Godfrey Sykes: The Camino del Diablo: With Notes on a Journey in 1925, *Geogr. Rev.*, Vol. 17, 1927, pp. 62–74.

[12] Kirk Bryan: The Papago Country, Arizona: A Geographic, Geologic, and Hydrologic Reconnaissance with a Guide to Desert Watering Places, *U. S. Geol. Survey Water-Supply Paper 499*, Washington, 1925.

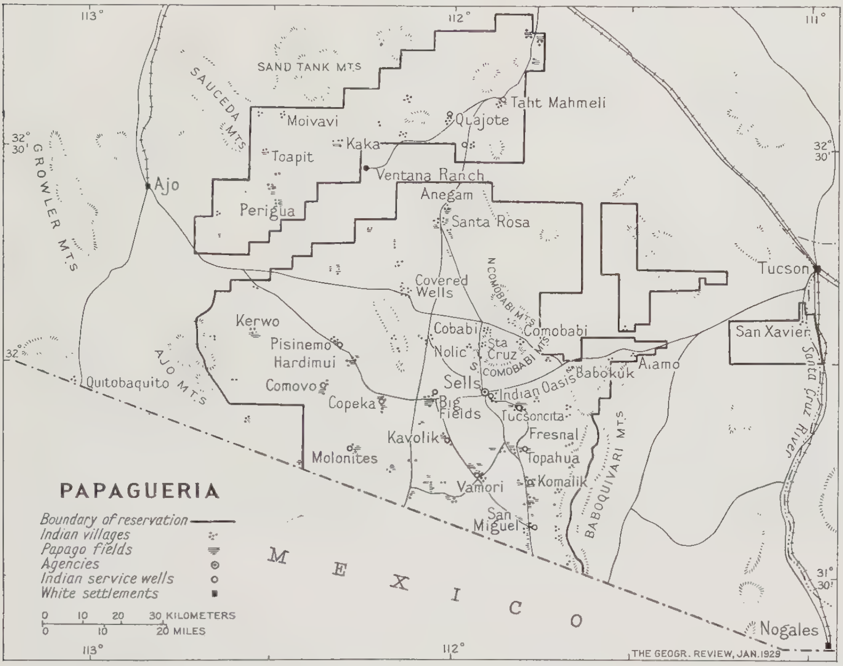

FIG. 9—Map of the Papago Indian Reservations. Scale slightly over 1 : 2,000,000.

The desert scarcity of water had also its compensation in that it was the Papago's best defense against the marauding Apaches. By the middle of the eighteenth century the Papagos had been driven west of the Baboquivari mountain wall, except for a group about the San Xavier Mission under the protection of Tucson. But the approaches to their country west of the Baboquivari were carefully guarded, and the passes were the scenes of desperate battles.

The periodic intervillage migration is typically illustrated by the people of Kaka and Moivavi in the west-central part of the reservation, who together constitute a community of about 250 people. They are about the most isolated of the villages. It is only within the last year that the government has succeeded in getting the children from these villages to schools. Kaka is a typical rancheria village, the huts being scattered around the cultivated area. The fields lie on a flat alluvial fan at the emergence of a canyon in low basalt hills which are outliers of the Sand Tank Mountains. The lavas almost surround the fan, and the houses are mostly located on this elevated land. The Indians assist nature in spreading over the fan the waters which pour down the canyon after the occasional heavy summer rains. There is no well here, the only attempt at drilling having encountered porous basalt at no great depth. The Indians depend upon their *charco*, and formerly when it dried up they were compelled to leave or bring water from Moivavi 16 miles away in the mountains. Now a few remain and haul their water from the deep well on the Ventana ranch, six miles away.[14] When the water in the *charco* becomes low most of the Indians move up to Moivavi. The water here is obtained from a well in the bottom of a sandy mountain wash; the village is built on the small grassy flats above. The well, which is typical of the winter rancherias, is 32 feet deep and timbered but fills up whenever there is a heavy rain. Upon returning to Moivavi the first task is the laborious redigging of the well.

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[13] Raphael Pumpelly: Across America and Asia, 3rd edit., New York, 1870, p. 38.

FIG. 10—Storm clouds over the Baboquivari Range, Papago Indian Reservation.

The movements between villages are timed with reference to the crops and the rains. The summer crops, chiefly squaw corn, beans, pumpkins, squash, and watermelons, are planted with the arrival of summer rains usually in July. If water is scarce, most of the Indians then go back to Moivavi to return for the harvest in October, after which they again go back into the mountains. Before the introduction of wheat the Papagos lived at their temporals only during the summer months; but now wheat is the most important crop, and it is necessary for the Indians to come to their temporals for its sowing in December, January, or as late as February if the rains are delayed. It is usually harvested about May, and, as there are no rains at this time of the year, water must be hauled from the Ventana ranch.

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[14] The Ventana ranch grazes about 125,000 acres of land on "the strip" which was withheld from the reservation to give right of way for a railroad at the time under consideration from Tucson to Ajo. The writer is indebted to Mr. McKinney, owner of the ranch, for valuable assistance and information concerning the Papagos.

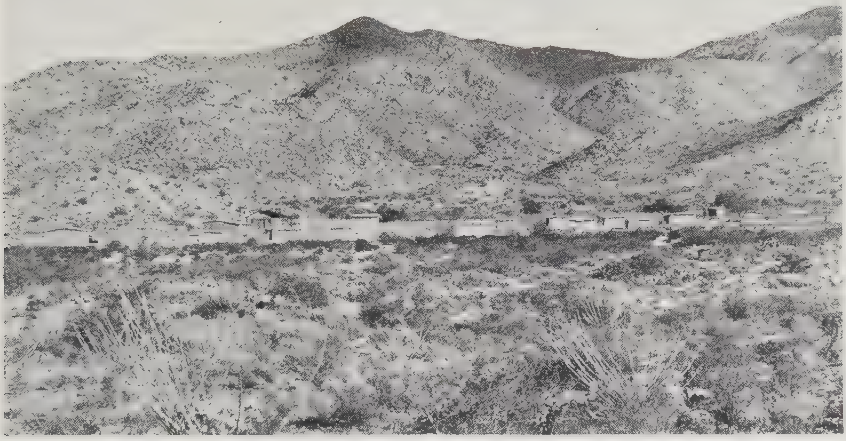

FIG. 11—Babokuk, a typical Papago village in a cove of the Baboquivari Range. The bare, thorny-stemmed *ocatilla* is conspicuous in the foreground.

The Indians are effective agents in checking natural erosion as they spread the waters from the washes over their fields. Above the temporals or villages the washes may be deep erosion channels, while below they may not be at all apparent. Shallow ditches sometimes extend out from the fields for more than a mile to collect the surface run-off. But the rains are uncertain, and sometimes the crop must be reseeded, and sometimes there is no harvest. The bean crop in 1927 had to be put in three times on some parts of the reservation. If planted too near the washes, the crop may be washed out; if too far away, it may dry up. This year a dry spring was followed by a record-breaking rain, which washed out much of the seed planted for summer crops and made it necessary to replant. The spring drought resulted in an almost complete failure of the wheat crop except with the Kaka Indians who had the largest yield. The United States Indian Service has in late years dug a number of wells convenient to the temporals. Permanent villages have developed about these, but many of their people still migrate a great deal from one village to another.

A boon hardly second to the digging of wells was the introduction of cattle among the Papagos, and now they graze and sell many.

The Indians of the eastern part of the reservation have profited most from the cattle, having the better grazing lands. Before the late series of dry years many of them had become fairly well-to-do; but, in spite of abundant pasturage last year, there are only about half as many cattle as there were a few years ago.

The largest of the temporals is at Big Fields where a great block of land is under cultivation with the homes of the Indians scattered around the margin. Indians come here from several of the villages lying around the mountains, especially from Cobabi, Comobabi, Nolic, and Santa Cruz on the flanks of the Comobabi Mountains. A well has now been drilled by the Indian Service, and some people always remain. Similar scattered farming villages that have been given a degree of permanency by government wells are Topahua, Komalik, Vamori, Indian Oasis, and San Miguel west of the Baboquivari Mountains. Formerly these Indians had their winter rancherias along the Baboquivari Mountains. Now the population has become differentiated as a result of the influences emanating from the agency at Sells. Those living at the agricultural villages with government wells are the most progressive and wealthiest of the Papagos. On the mountain pediment and in the mountain coves at the old water holes are found the most conservative Papagos. They are largely dependent for a livelihood upon cutting mesquite wood and marketing it in Tucson, from 40 to 80 miles distant. Fully a week is involved in a transaction bringing about $6.00. In addition wagons must be kept up and horses fed on the long haul across the desert.

Santa Rosa, farther to the northwest, is the center of an area with about 3000 acres of cultivated fields. In 1920 about 200 tons of wheat was handled from Santa Rosa, and almost none has been handled since. In spite of a government well, drilled in 1915, the population varies from three or four families to as many as 700 persons. The digging of the well was protested by the Indians, for they believed that if the waters were once let loose they might not be controllable. Near Santa Rosa is a shrine where according to tradition the waters once flowed, threatening inundation of the country, and were only stopped when two children were thrown into the hole and it was covered with stones. The shrine is still religiously cared for and guarded, for should the stones be removed the waters would flow again. There is some ground for their superstitious fears: even this last summer, as in times past, Santa Rosa was almost washed away in the torrential downpour that followed the too successful rain-making *fiesta* and incantations of old "Doctor Lopez," medicine man and chief, who still reigns in the confidence of his people.

The people on the western part of the reservation, having the poorest lands, are themselves poorest; and in the summer many leave the reservation to seek employment in the cotton fields of the Salt

River oasis, nearly a hundred miles away. The journey both ways consumes about a week, and the season may be interrupted by a *fiesta* or two requiring return to the villages. But time enters little into the economy of the Papago.

Other migrations are occasioned by the religious *fiestas*. Each year many hundreds, especially from the western part of the reservation, cross the boundary on a pilgrimage to Magdalena, Mexico, and return for their *fiesta* flying the Mexican flag, while those at home go out with hands raised and palms out to meet those returning. They will save their money for months or even sell their cattle to be able to go to Mexico to celebrate at this time.

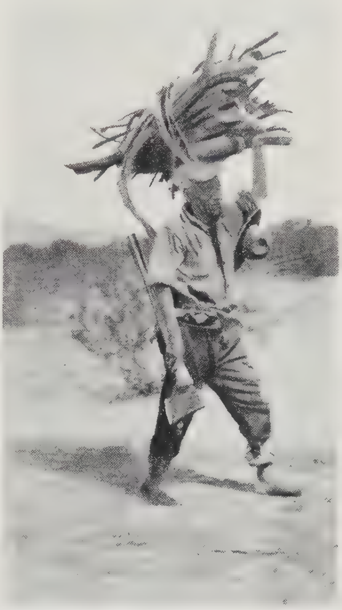

FIG. 12.—"Doctor Lopez," medicine man, rain maker, and chief of the Santa Rosa Papagos.

THE MOUNTAIN COUNTRY AND PEOPLES

The name Apache is frequently applied indiscriminately to all the peoples of the mountain provinces, as all depended in part upon raids for their subsistence and were the terror of the peace-loving plains tribes and later of the white settlers. The Yavapais, Yuma Apaches or Mohave Apaches, lived in a similar environment with the true Apaches and were similarly adjusted to it even to the building of their houses. They sometimes allied themselves with the Apaches for war purposes, but otherwise they remained distinct. Nor could the true Apaches be considered in any sense a nation. In spite of a common language, consanguinity, and the occupation of contiguous territory, most of the bands fought each other and lived in continual fear of reprisal. Their mountain environment prevented other than temporary unity. The Apache tribes were never all at once on the warpath, and from peaceful tribes were obtained the Apache scouts who rendered invaluable services in subduing their hostile *confrères*.

From the southeast corner of Arizona towards the northwest extends a series of roughly parallel mountain ranges with valleys between. This mountain province as related to the Indians may be divided into four subprovinces. The White Mountain region is located to the east. The Bradshaw Mountains with the surrounding

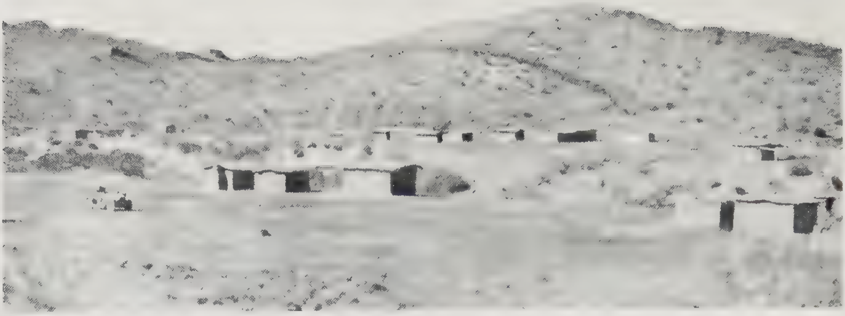

FIG. 13

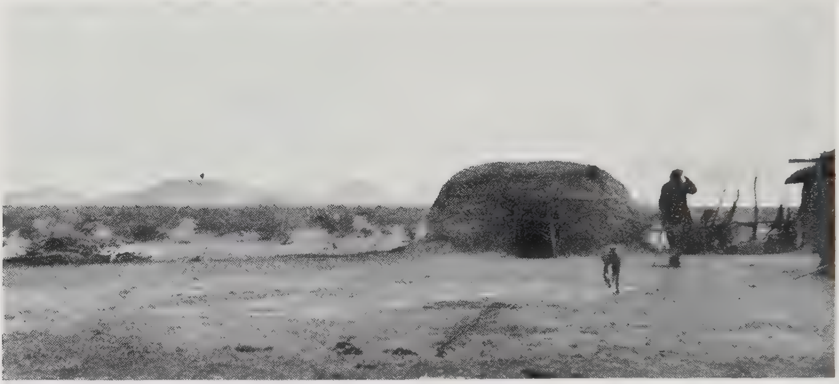

FIG. 14

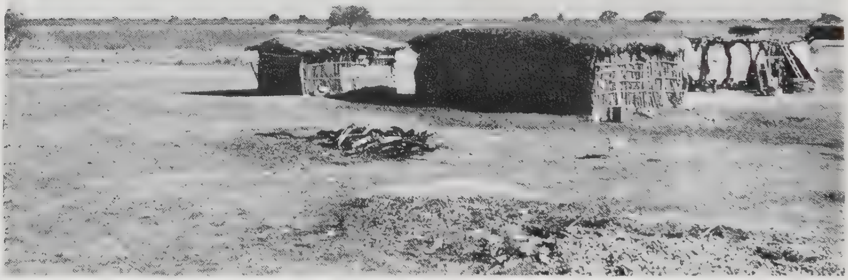

FIG. 15

FIG. 13—Moivavi, mountain village, Papago Indian Reservation. The Indians from Kaka move here when their water supply becomes low (see Fig. 16).

FIG. 14—Primitive "ki" at Quajote, Papago Indian Reservation.

FIG. 15—Typical Papago rancheria, Big Fields, Papago Reservation. Cultivated fields in background.

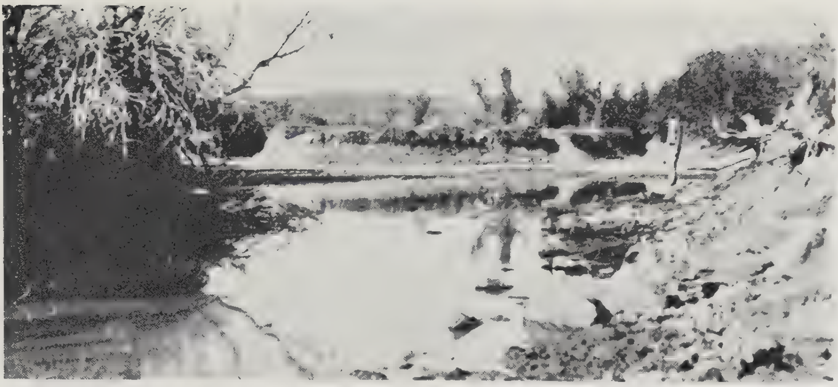

Fig. 16

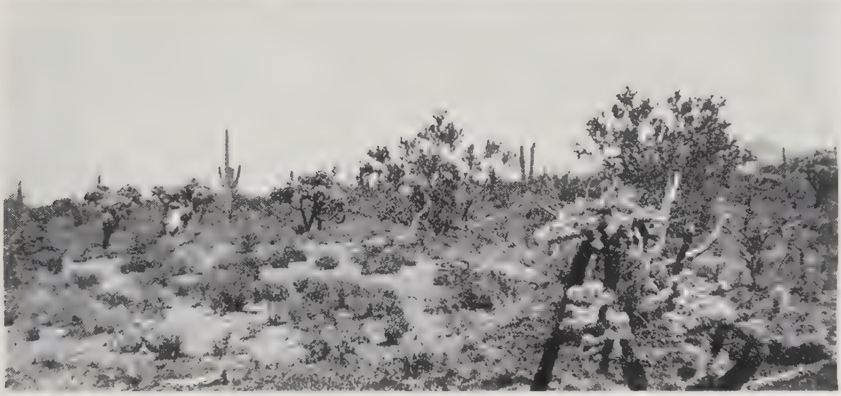

Fig. 17

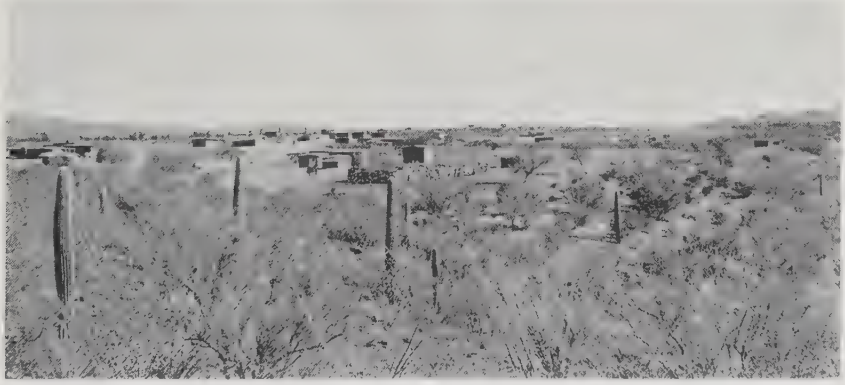

Fig. 18

Fig. 16—*Charco* at Kaka in early April, 1928—a dirty mudhole from which comes the water for all domestic purposes as well as for the animals.

Fig. 17—Vegetation near the Comobabi Mountains. Thorny cholla cactus and the low sagelike Franseria in foreground; *Sahuara* (giant cactus), cholla, *palo verde*, and ironwood in background.

Fig. 18—Cobabi, a piedmont village, Papago Indian Reservation. Typical mountain pediment vegetation in the foreground. *Sahaura*, *ocatilla*, and *palo verde* are conspicuous.

lower mountains are another distinct group to the west. Between the two groups extend long mountain blocks as the broken-down border zone of the Colorado Plateau. The intermont depressions, or structural valleys, are narrow in the north but widen to the southeast where they are also lower. A fourth subprovince may then be indicated to include the broad southern blocks, both elevated and depressed, as the Chiricahua Mountains, the Dragoon and Mule Mountains, San Simon Valley, and upper Gila Valley, Sulphur Springs Valley, and the San Pedro Valley. The Indians were grouped with reference to these mountain subprovinces, occupying the mountain valleys at the headwaters of the Gila and Salt rivers with their branches.

The mountain region is not only more rugged than the Pimería but differs also in climate and vegetation. The valleys average over 3000 feet in elevation, and the mountains generally rise more than a mile. The White Mountain province is all over a mile high and varies up to 11,000 feet. This area is in reality a subprovince of the Colorado Plateau, but the eastern part is made mountainous by numerous volcanic cones, and the western part is made rugged by the numerous canyons cut through horizontal lava beds by the headwater streams of the Salt River.

The rainfall varies from 15 to 25 inches, being greatest in the White Mountains. Some of the wider valleys in the south, with less than 15 inches of rainfall, are quite arid. The winters are to be reckoned with; in the higher areas, like the White Mountains, they are fairly severe, and the communities are isolated by the heavy snowfall. The higher mountains carry pine forests with scrub oak dominating their flanks. The broad lower valleys are semidesert, and the higher ones grassy if not scrub.

The Apaches, including the Mohave and Yuma Apaches, formerly consisted of four main groups distributed according to the four mountain subprovinces as outlined above.

The White Mountain Apaches lived in the narrow valleys along the swift-flowing streams on the Salt River watershed in the White Mountains. The chief center of population was along the White River, where the agency is now located. The Tonto Apaches lived in the Tonto Basin and the narrow valleys tributary to it. A separate group occupied the valley of the Cibecue Creek farther east. The Chiricahua Apaches lived around the Chiricahua Mountains and the San Simon and upper Gila valleys. They also roamed over the Sulphur Springs and San Pedro valleys and were the most troublesome of the Apaches and the last to be subdued. Before and after white settlement in the adjacent areas they made frequent raids into Mexico. A minor group, the Aravaipa Apaches, were located along the stream of that name and at its junction with the San Pedro

River. All these people were later confined to the San Carlos and Fort Apache or White Mountain reservations. The San Carlos Apaches now live along the San Carlos River and that part of the Gila on the reservation. The chief centers of Apache population are at San Carlos, where the agency is located, at Bylas on the Gila, and at Rice on the San Carlos River.

The Mohave and Yuma Apaches lived around the Bradshaw Mountains in the narrow valleys of the streams flowing south to the Salt or Gila rivers; also in the valley of the Verde River to the east. The Verde Valley reservation is the only part of their domain reserved to them, most of them having been removed to the Apache reservations. About 200 of them now live in the lower Verde Valley, and about 400 in the upper Verde Valley around Camp Verde.

Military forts were distributed among the hostile mountain peoples. Fort Whipple and Fort Date Creek near Prescott and Fort McDowell on the Verde were located in the midst of the Yuma and Mohave Apaches, though the last fort served also as a base of operations against the Tonto and White Mountain Apaches. Fort Apache was located in the midst of the White Mountain Apaches; and Fort San Carlos and Fort Thomas on the upper Gila, Fort Bowie at Apache Pass, and Fort Frank in the upper San Simon Valley were bases of operation against the Chiricahua Apaches.

The Apaches in common with nearly all the southwestern tribes usually chose to camp on a terrace somewhat removed from the water. The higher site was better capable of defense, but the principal reason was that the bottom lands are hotter in summer and colder in winter than the terraces above.[15] They subsisted in part by primitive agriculture in the mountain valleys, producing the usual Indian crops of corn, beans, squash, and melons. Like the other Indians of the south they also depended partly upon wild foods like mesquite beans, mescal, and the fruits of the cacti. The greater rainfall of the mountain region eliminated the necessity for irrigation.

A considerable part of the area of the narrow flood plains of the upper Gila and San Carlos valleys in the vicinity of San Carlos and Rice is now cultivated by the Indians. The completion of the Coolidge Dam will submerge most of this land along the Gila, and the Indians will have to move to the Fort Apache reservation or will be given the privilege of taking up allotments on the land along the lower Gila, which is to be watered by the project.

In addition to farm crops the Indians now have beef cattle, pigs, and chickens. With few exceptions they adhere to their primitive huts, wikiups, built by bending over poles, binding them at the top, interlacing with branches, and covering the whole with brush or grass. Canvas has now become the chief covering material.

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[15] J. H. McClintock: Arizona (3 vols., Chicago, 1916), Vol. 1, p. 29.

After being confined to the reservations the Apaches were rationed by the government until 1902. They are now better situated than any other Arizona Indians with regard to wage-earning employment and make good use of the opportunity. They are also the best laborers and command the highest wages. Important Apache villages are located close to the important mining centers near the reservations as at Globe and Superior. The largest of all is now temporarily located near the Coolidge Dam site, the construction employing a large number of them. Until the recent completion of the Horse Mesa Dam on the Salt River, a similar village was located near by.

The primitive simple Indian, as described above, is slowly but surely vanishing from the scenes. The smaller groups are already disappearing or being submerged in neighboring populations. As development of the agricultural and mineral resources on or adjacent to the reservations proceeds, many of the Indians will doubtless be induced to sell their lands, and will scatter and intermarry among others. To the nation at large all this will be applauded as progress, but to the geographer there must be regret over the obliteration of so much that is unique.[16]

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[16] Compare A. L. Kroeber: Native Culture of the Southwest, *Univ. of California Publs. in Amer. Archaeol. and Ethnol.*, Vol. 23, 1928, pp. 375–398.

THE NEW TERRITORIAL DIVISIONS OF CHILE WITH SPECIAL REFERENCE TO CHILOÉ

William E. Rudolph

WHEN President Ibañez made over the map of Chile a year ago, he drew from out of its obscurity the island province of Chiloé by linking it to the adjacent progressive section of the mainland.

The last part of the country to attain its independence, Chiloé was the southernmost of the eight original provinces into which Chile was divided one hundred and two years ago. In the beginning it included not only the island of Chiloé and adjacent archipelagoes but also portions of the continent. Later on, when colonization of this mainland had begun, Chiloé relinquished all save its islands to the newly created province of Llanquihue. The island province did not progress with other subdivisions of the nation—while the latter were developing their natural resources Chiloé was stagnant. Now and again appeal was made for government aid to develop its fisheries. But more powerful political groups had other uses for the government funds than that of establishing a new industry within a decadent province. Now all is changed. Chiloé regains its lost portions of the mainland. Its capital is removed to Puerto Montt, the southern terminal of Chile's 1900 miles of continuous Longitudinal Railroad. The senators and deputies sent from this province to the National Congress will no longer be slighted, for they represent a population which is contributing materially to the income of the nation. Chiloé is no more on the outside.

Revision of Territorial Subdivisions in 1927

Before proceeding with our description of Chiloé, it would seem apropos to touch upon this recent revision of territorial subdivisions. It was on the thirtieth day of December, 1927, that President Carlos Ibañez's decree was published in the press throughout Chile, announcing that the nation would be divided into 16 provinces and 2 territories instead of into 23 provinces and 1 territory as formerly. Sixty-five *departmentos* were named as subdivisions of the provinces in place of the 82 which had existed previously.

The proposed changes were cordially received throughout the nation. They went into effect on February 1, 1928. From Table I it is seen that all of the eight original Chilean provinces have been

TABLE I—RELATION BETWEEN OLD AND NEW SUBDIVISIONS OF CHILE

PROVINCES CONTINUED UNDER NEW SUBDIVISION	DATE OF BECOMING A PROVINCE	OLD CAPITAL	NEW CAPITAL	NEW ORGANIZATION INTO DEPARTMENTOS	FORMER ALLOCATION OF TERRITORY OF DEPARTMENTOS
Tacna	Following War of the Pacific—still in dispute with Peru	Tacna	Tacna	Tacna Arica	No changes
Tarapacá	1884 (acquired from Peru)	Iquique	Iquique	Pisagua Iquique	No changes
Antofagasta	1888 (acquired from Bolivia with certain Chilean territory added)	Antofagasta	Antofagasta	Tocopilla Loa Antofagasta Taltal	No changes
Atacama	1843	Copiapó	Copiapó	Chañaral	*
				Copiapó	*
				Huasco	*
Coquimbo	Original 1826	Serena	Serena	Serena	*
				Elqui	*
				Ovalle	*
				Illapel	*Includes small transfer from Aconcagua
Aconcagua	Original 1826	San Felipe	Valparaiso	Petorca	*
				San Felipe	*
				Andes	*
				Quillota	Transferred mostly from Valparaiso; balance*
				Valparaiso	Transferred mostly from Valparaiso; a small portion from Santiago; balance*
Santiago	Original 1826	Santiago	Santiago	Santiago	*Small transfers from O'Higgins and Aconcagua
				Melipilla	*
				Maipo	Transferred from O'Higgins
Colchagua	Original 1826	San Fernando	Rancagua	Rancagua	Transferred mostly from O'Higgins; balance*
				Cachapoal	Transferred partly from O'Higgins; balance*
				Caupolican	*
				San Fernando	*
				Santa Cruz	Transferred partly from Curicó; balance*
Talca	1833	Talca	Talca	Curicó	Transferred from Curicó
				Mataquito	Transferred partly from Curicó; balance*
				Lontué	*
				Talca	*
Maule	Original 1826	Cauquenes	Linares	Loncomilla	Transferred from Linares
				Linares	Transferred from Linares
				Parral	Transferred from Linares
				Constitución	Transferred partly from Talca; balance*
				Cauquenes	*
Nuble	1848	Chillán	Chillán	San Carlos	*
				Chillán	*
				Bulnes	*Includes small transfer from Concepción
				Itata	Transferred from Maule
				Yungay	*Includes small portions from Concepción and Bio-Bio
Concepción	Original 1826	Concepción	Concepción	Tomé	*
				Concepción	*
				Yumbel	*
				Coronel	Transferred partly from Arauco; balance*
				Arauco	Transferred from Arauco
Bio-Bio	1876	Los Angeles	Los Angeles	Laja	*
				Mulchén	*
				Angol	Transferred mostly from Malleco; balance*
Cautin	1887	Temuco	Temuco	Traiguén	Transferred from Malleco
				Victoria	Transferred mostly from Malleco; balance*
				Lautaro	*
				Temuco	*
				Imperial	*
				Villarrica	Transferred from Valdivia
Valdivia	Original 1826	Valdivia	Valdivia	Valdivia	*
				La Union	*
				Osorno	Transferred from Llanquihue

*Indicates territory formerly within same province.

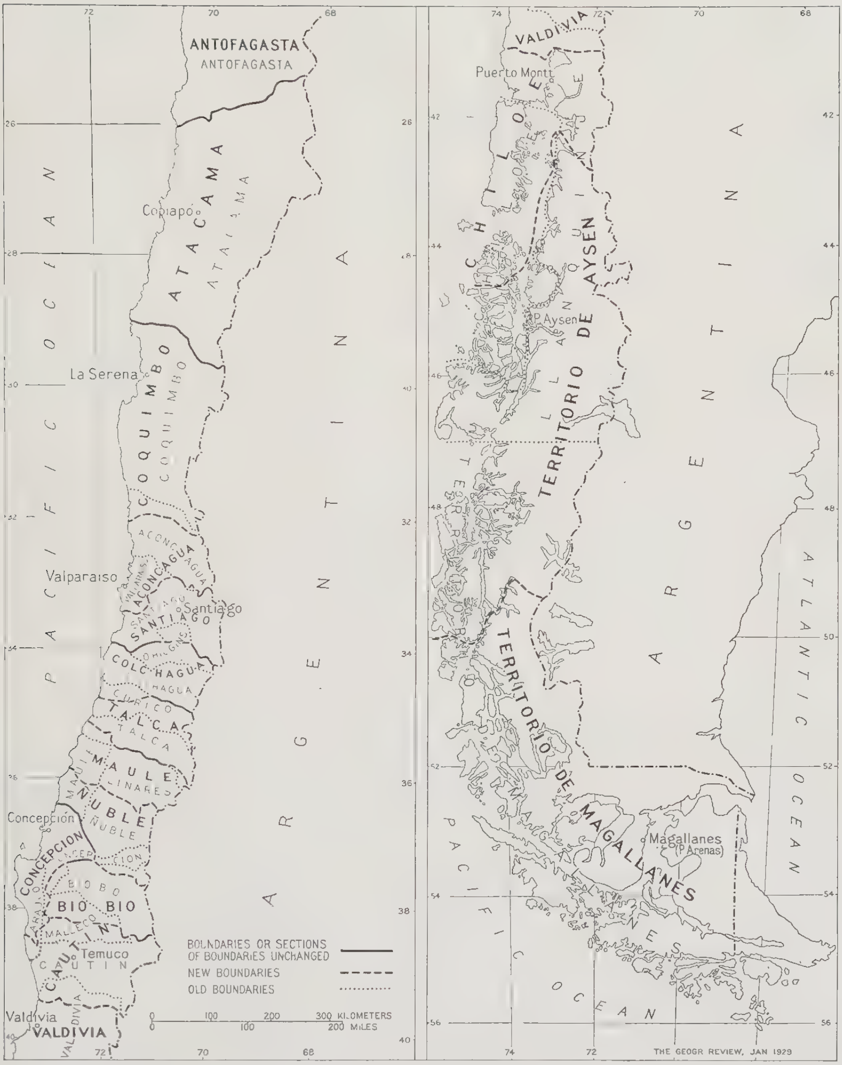

FIG. 1—Map showing the changes in the provincial subdivision of Chile. Scale approximately 1:13,000,000.

Chiloé	Original 1826	Ancud	Puerto Montt	Llanquihue Ancud Castro	Transferred from Llanquihue * *
Territory of Aysen			Puerto Aysen		Made up from transfers from Llanquihue, Chiloé, and Magallanes
Territory of Magallanes		Magallanes (formerly called Punta Arenas)	Magallanes	Natales Magallanes Tierra del Fuego	* * *

Provinces discontinued under new subdivision are: Valparaiso (Valparaiso), 1842; O'Higgins (Rancagua), 1883; Curicó (Curicó), 1865; Linares (Linares), 1873; Arauco (Lebu), 1859; Malleco (Angol), 1887; Llanquihue (Puerto Montt), 1861.

retained. Of the twelve provinces created from territory of the original eight during the first century of the nation's history, seven have been discontinued. The three provinces formed from territories ceded by treaties following the War of the Pacific remain unchanged. The commission which studied and made recommendations for the new division stated frankly in its report that new provinces had been created from time to time, not because they were required for administrative purposes, but merely to gratify local sentiment or to further schemes of politicians.[1]

The New Provincial Boundaries as Compared to the Old

When it is recalled that only short stretches of Chile's 4000 miles of national frontier had been adjusted prior to the beginning of the present century, it can be understood why the defining of provincial boundaries, many of them located within barren deserts and virgin forests, received scant consideration. A large number had been laid out while the nation was still young, and they had become obsolescent. Others had been changed frequently, and latest maps failed to show them correctly.

The outstanding feature of the new subdivision is its simplicity. Each province now extends from the Pacific Ocean to the eastern frontier, excepting Concepción, without international frontier, and Bio-Bio, without coast line. Formerly there were five provinces which had no coast line and five which did not extend to the frontier.

Of the new boundaries many now coincide in general with lines of watershed barriers instead of following watercourses. Valdivia, for instance, no longer has the Rio Toltén at its north and the Rio Bueno at its south—its limits now follow the heights of land farther south in each case. Such a change, by reducing a single province to the waters of a single drainage system, settles for all time questions of ownership where water resources may become important for power or for irrigation. It has also removed the river boundary, which complicates the administration of communities on opposite sides of the river.

Means of communication have also been taken into consideration, the new boundaries linking to a departmental or provincial capital those communities which have most of their business with that capital. This has united communities with similar aims and interests and has tended to eliminate the minorities from these standpoints, which are too often completely neglected as a result of being inadequately represented.

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[1] La nueva división territorial de la República [being the report of nine members of the Commission to the Minister of the Interior], *Rev. Chilena de Hist. y Geogr.*, Vol. 57, 1928, pp. 6–38, Santiago de Chile. The governmental decree is based on the commission's report, though it departs from its recommendations in detail.

A single geometric boundary which appeared on the old map, the 47th parallel of latitude between the province of Llanquihue and the territory of Magallanes, has been taken out.

Results To Be Attained from the New Subdivision

The new subdivision, by decreasing the number of provincial and departmental organizations, should be of material assistance toward attaining a balanced budget for Chile. It should also simplify and speed up the machinery of the government. For example, the coal mines and coal shipping ports now lie entirely within the province of Concepción, whereas formerly they were divided between Concepción and Arauco. Measures are at present under way for increasing the output of these coal mines, a tax upon foreign fuel oil having been instituted to provide funds for subsidizing this industry. It should work out advantageously to have the coal industry thus located within a single province, in view of the controversies that might arise with two provincial organizations complicating the administration of the enterprises.

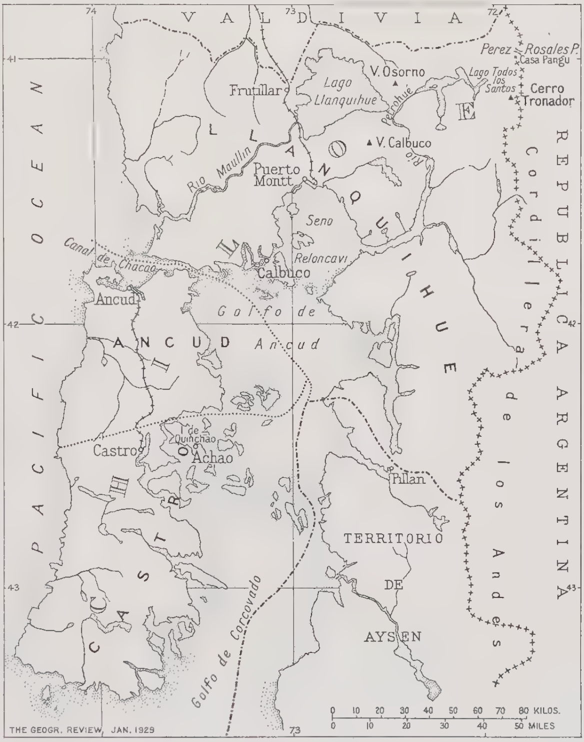

FIG. 2—The new province of Chiloé: The extreme south, comprising islands of the Chonos Archipelago and the Guaitecas Islands, is not shown. Compare Figure 1. Scale approximately 1:3,250,000.

Doubtless the primary aim of the Ibañez government in promulgating the changes was ultimate decentralization of administrative functions to the provinces. Chile, more than 2500 miles long and averaging only 111 miles in width, is hardly adapted to being managed from a central seat of government. Yet in this country the provincial officers have thus far been accorded little authority; all public business, even trivial matters affecting a limited region, being transacted at the nation's capital.[2] People of the northern and southern regions of the country consider themselves grossly neglected by the legislators at the capital. Too often their needs are not fully understood there. The official at Santiago is apt to think of the arid northern provinces as regions where rain is unknown and modern housing is quite unnecessary. He is too far away to comprehend the sufferings that follow a single freak rainstorm of the desert, such as the exceptional rains of 1911 which spread devastation in the nitrate fields. Thus, lavish appropriations for ill-advised public works are approved for certain sections, while urgently required improvements are refused to others. There is small wonder that such government has been expensive and inefficient.

Decentralization of legislative and judicial functions from the Chilean national capital to the provincial seats cannot be effected overnight—it must be worked out slowly. The way has been cleared by the proper division of the nation into states which will work as units in harmony with one another.

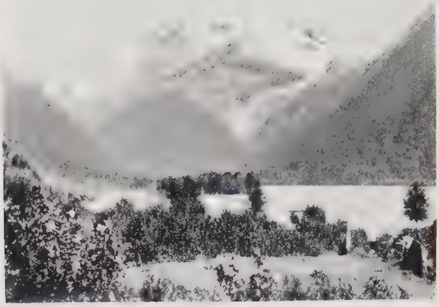

FIG. 3

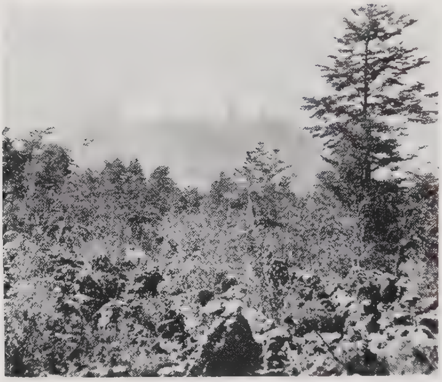

FIG. 4

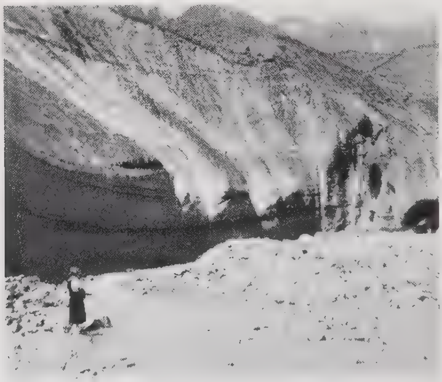

FIG. 5

FIG. 3—Looking up the glacial valley below Tronador leading to Lake Todos los Santos.

FIG. 4—A comparatively recent lava flow from Osorno, upon which new forest growth has sprung up.

FIG. 5—The face of a glacier flowing from Tronador. It is said to be receding at the rate of nearly three feet a year.

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[2] So unimportant is the province that in Chile one speaks of visiting a certain city or a section near a city, of traveling to the south, the north, the cordillera, or the coast; seldom is the name of the province mentioned. It has not even been customary to include the name of either province or *departmento* in addressing mail.

The New Province of Chiloé

To return to our discussion of the province of Chiloé. Chile's three dominant physical features—the Coast Range, Central Valley, and Cordillera of the Andes—have been invaded by the sea in the far southern part of the country. Near the forty-second parallel of latitude the Coast Range disappears into the waters of the Canal de Chacao. It reappears as the island of Chiloé and continues in a series of archipelagoes. Only at the narrow boggy isthmus of Ofqui, forming the Peninsula de Taitao, is the Coast Range again joined to the mainland. The Central Valley contains a number of large lakes before disappearing at the Gulf of Reloncavi. Southward it forms an intricate system of canals. The steep western slopes of the Andes fall off abruptly into the sea, causing a curiously denticulated coast where their bulwarks have been invaded at innumerable fiords and estuaries.

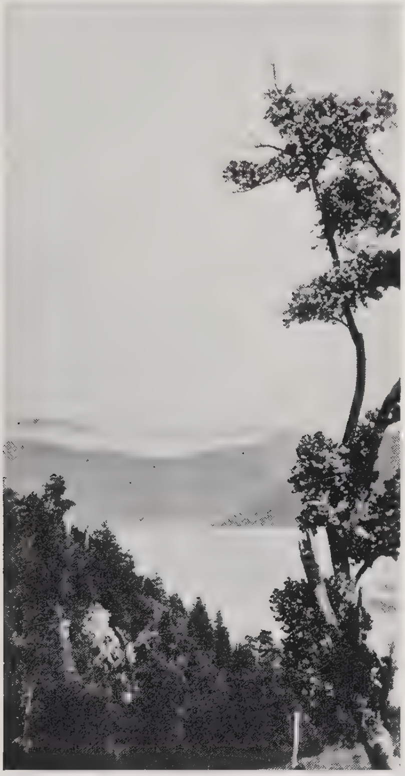

Fig. 6

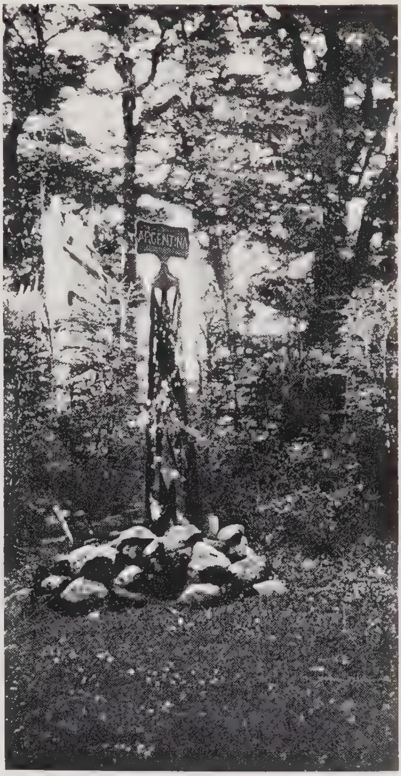

Fig. 7

Fig. 6—Lake Todos los Santos from Peulla.

Fig. 7—At the international frontier along the old trail over Pérez Rosales Pass. Instead of depositing stones according to the custom of the older people of the north, travelers have been leaving daisies.

The province of Chiloé now comprises the portion of the continent lying between a watershed line approximating the 41st parallel at the north and an irregular line south of the 42nd parallel at the south, the large island of Chiloé (about 3000 square miles), several other large islands, and the archipelago of Chonos as far south as the Canal King at about latitude 44° 40′ S. Within the continental portion of the province are two large lakes, Llanquihue and Todos los Santos, the former having an area of about 300 square miles.

Glacial and Volcanic Features

The surface features of the province are for the most part the result of glaciation. Lakes Llanquihue and Todos los Santos were originally excavated by ice. Great chains of terminal moraines have been left about their borders. Some of the glacial structures have undergone modification by the forces of vulcanism. These lakes, originally one, were separated by a lava flow from Osorno, which established a higher level for Todos los Santos and caused it to find a new outlet through the Rio Petrohué to the Gulf of Reloncavi (Fig. 2). The narrow tongue of land between the two lakes is composed of volcanic sands, in which large tree trunks are found imbedded.

The fiords and maritime channels appear to have been glacial troughs which extended below sea level, the Canal de Chacao, at latitude 41° 47′, being the northern limit of glaciers which reached the open sea. This view seems to the writer more acceptable than the theory that the archipelagoes are due to depression of the Coast Range until only the highest portions were left above water. The weight of evidence points to elevation rather than depression in later times. Darwin found sediments ascribed to floating ice upon the island of Chiloé. Near Ancud he noted a great bed of shells of modern species, from among which large forest trees were growing at an elevation of 350 feet.[3] Sundt mentions large erratic blocks, evidently transported by floating ice, both north and south of the Canal de Chacao—such as to indicate that these lands had been at least 200 feet below sea level during the glacial period.[4] The lower height of the Andes in this region than in the north must be to some extent due to glaciation and to mechanical disintegration under a wet climate during the last era.

A number of the mountains are volcanic cones which have been active in the recent past. Calbuco, 6611 feet, had periods of eruption in 1893, 1895, and during April, 1917. Since then it has frequently given off "smoke." During eruptions of this volcano it was feared that a lava flow might descend to the Rio Petrohué and dam its course,

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[3] Charles Darwin: Journal of Researches, etc., 2nd edit., London, 1860, p. 297.

[4] Lorenzo Sundt: Estado actual de los conocimientos jeolójicos en Chile, *Estadística Minera de Chile en 1906 i 1907*, Vol. 3, Santiago, 1909, pp. 503–514; reference on p. 510.

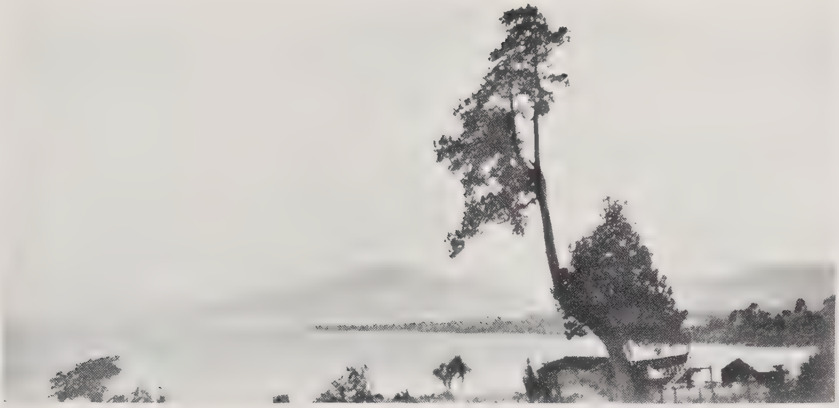

FIG. 8

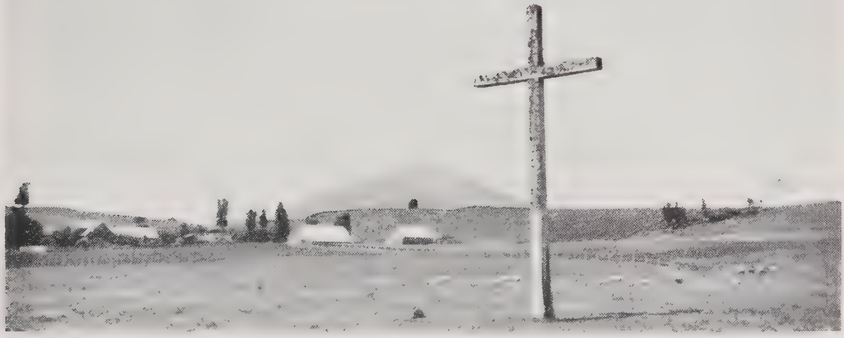

FIG. 9

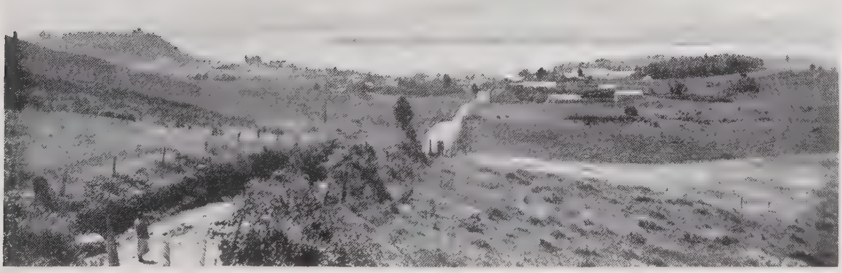

FIG. 10

FIG. 8—The cone Osorno from the southern shores of Lake Llanquihue.
FIG. 9—The volcano Calbuco, viewed from Lake Llanquihue.
FIG. 10—Cultivated lands upon the moraine bordering Lake Llanquihue, where half a century ago was dense forest.

restoring the older conditions under which Lake Todos los Santos drained toward the west. This would have resulted in heavy damages from inundations, but luckily none of the lava reached the river. The 1917 eruption, according to observers in the region, sent out little in comparison with that of 1893. A large quantity of sulphur appeared as a result of the last disturbance.

Of Osorno, 8727 feet, there is no record of activity more recent than a light eruption during the year 1837. Darwin saw this mountain in eruption from the island of Chiloé on January 15, 1835. Osorno has a crater about 1500 feet in diameter in which snow has accumulated. Vapors have been noted here by climbers of recent years. That volcanic activity in this section of Chile is by no means concluded was shown on October 4, 1927, when the cone Llaima, hardly 200 miles north of Chiloé, threw out cinders for several days.

A Region of Heavy Rainfall

The province lies in the region of heavy rainfall. During the summer months the fall is somewhat less than in other seasons of the year. Records over a period of 34 years give Puerto Montt an average of 2160 millimeters (85 inches) of rainfall. Ancud, for 23 years, had 2092 millimeters (82 inches).[5] At nine observation stations in the region of this province rain occurred on more than half of the days of the year, for an average, during the years 1911 to 1916. At Guafo, northwest of the Chonos, the average was 259 days. Much of this rain was in the form of showers, however, the number of days recorded as continuously cloudy being considerably less than those during which precipitation occurred. Peulla (620 ft.), at the head of Lake Todos los Santos, had an average of 133 inches from 1918 to 1925, Casapangue (1080 ft.) had 139 inches. Frutillar, the driest station of the region, east of Lake Llanquihue had 66 inches.[6]

Snow is most unusual at seaboard in the region, its northern limit being the 47th parallel. Even at passes in the Andes, reaching three and four thousand feet, there is seldom a considerable amount of snowfall in winter. The perpetual snow line is at about 6000 feet at the 43rd parallel. Glaciers reach the sea only south of the 46th parallel.

The difference in temperature between summer and winter is much less than the latitude would indicate. The range at Puerto Montt was from 15.8° C. (60.4° F.) average in January to 8.1° C. (46.6° F.) in August, with a yearly average of 11.4° C. (52.5° F.), during the period 1911 to 1916.[7] The same records for Ancud give

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[5] Mark Jefferson: The Rainfall of Chile, *Amer. Geogr. Soc. Research Ser. No. 7*, New York, 1921, p. 27; tabulation from data of the Inst. Meteorol. y Geofísico de Chile, Sección Lluvias.

[6] Lluvias mensuales, 1918–1925, *Servicio de Meteorologia Agricola, Publ. No. 37*, Santiago, 1926.

[7] Tables quoted by Walter Knoche in chapter on "Breve estudio del clima de Llanquihue y Chiloe," in Turismo en la Provincia de Llanquihue (by German Wiederhold), Santiago, 1921, p. 43.

15.3° C. (59.5° F.) January, 8.4° C. (47.1° F.) August, 11.3° C. (52.3° F.) yearly average. At the island Melinka, 43° 54′, it ranged from 13.4° C. (56.1° F.) in January to 7.4° C. (45.3° F.) in August, with an average of 9.9° C. (49.8° F.). Such equable climate is due to the high degree of cloudiness. When the sun does shine in southern Chile, upon its snow-capped ranges and glaciers and beautiful woods, there is a rare treat for the traveler—and such days are more prevalent than the bad ones during three months of the year. Perhaps I appeared too enthusiastic over a period of fine weather at Ancud, for the proprietress of the hotel interrupted: "But, Señor, what of the other nine months, with weeks upon weeks of rain, when we can only stay close to the fire to keep comfortable? What of the winter when we scarcely put foot into the street?" We needed no confirmation of her words. The odor of damp mold from the woodwork of all the houses we entered told its own story.

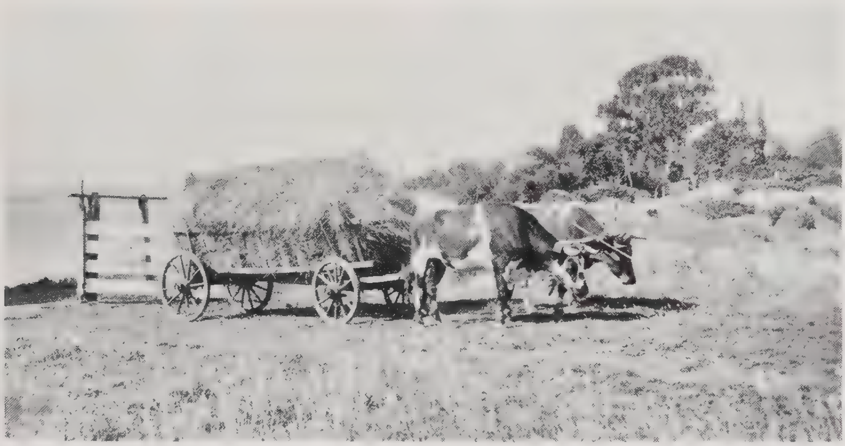

FIG. 11—In the farming region of northern Llanquihue.

THE FORESTS

Well-nigh impenetrable forests are the result of the heavy precipitation. The soil is so wet that roads are of little avail. In earlier times persons have lost their lives in the mud. Two men who traveled the length of Chiloé on horseback in recent years were accustomed to rescuing each other with a lariat. Corduroy roads are being built in the north of the province, however; and, while these do not remain in good condition for long, they have materially lessened the difficulties and dangers of travel. Certainly there has been improvement since the colonization days of 1856, when a newspaper stated that cattle stealing was unknown in the region inasmuch as no thief could escape with such booty through the damp forests.

The trees of these forests are in great part without value. Most common is the *coihue* (*Nothofagus dombeyi*), a very beautiful tree but a species all too abundant. "Too heavy and weak for lumber, too wet to burn, [these trees] simply keep out the sun and make a quagmire of the ground."[8] The *alerce* (*Fitzroya patagonica*) is a most useful wood, although scarce. It is one of the gigantic conifers of America, there being specimens 200 feet in height and 16 feet in diameter. Trees 4000 years old have been reported: trees over 2000 years old appear to be well authenticated. *Alerce* is used in large quantities for shingles. Other useful trees are the *lingue* (*Persea lingue*), used for furniture and floors, and the roble (*Nothofagus obliqua*) a dense timber of dark-red color, used for railroad ties and posts. The bark of the *lingue* is used for tanning.

Much of the smaller growth resembles that of tropical forests. Trailing parasites, ferns, cane, and dense underbrush abound. Tree ferns are found upon the island of Chiloé. Blackberry thickets cover the burned and cut-over lands that have not been cultivated. Much like the tropical forests from the standpoints of darkness, dampness, and impenetrability, the Chiloé forests differ from these in that they have few snakes or dangerous insects. A large hairy spider, noticed perhaps where a ray of sunshine pierces the darkness of the trail, is the only poisonous creature.

INDUSTRIES

In the Lake Llanquihue region agriculture and stock raising have come to rank with forestry as important industries. The soil is fertile, consisting largely of decomposed volcanic products, and the country is rolling. Clearing the land has been the difficult problem, for it is hard to keep fires burning in so wet a climate. Probably there are few places in temperate regions where, as in southern Chile, the forest fire is an aid instead of a menace. Advantage is taken of each spell of dry weather to start fires, which appear to require but little control. Smoke is seen in all directions in the settled portions during the summer months. Thanks to the patience and persistence of the settlers, large areas have been converted to farm land and pastures. The potato is found growing wild on the island of Chiloé, and it is generally considered that it originated in this region.

But by far the most important resource of Chiloé is its fishing, an industry still in its infancy in Chile. The waters about the province are rich in fish. At times of the year, after high tide, the natives scoop fish up in barrels from walled enclosures. Yet, whereas many settlements of the islands depend upon the sea for their living, only a very small portion of the available supply is utilized. Each winter

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[8] Mark Jefferson: Recent Colonization in Chile, *Amer. Geogr. Soc. Research Ser. No. 6*, New York, 1921, p. 13.

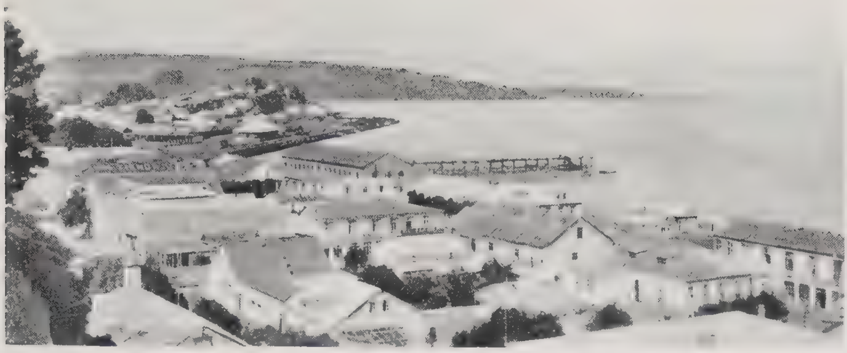

FIG. 12

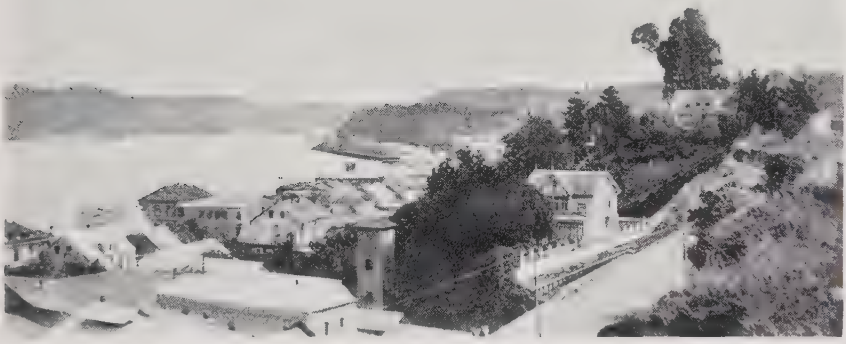

FIG. 13

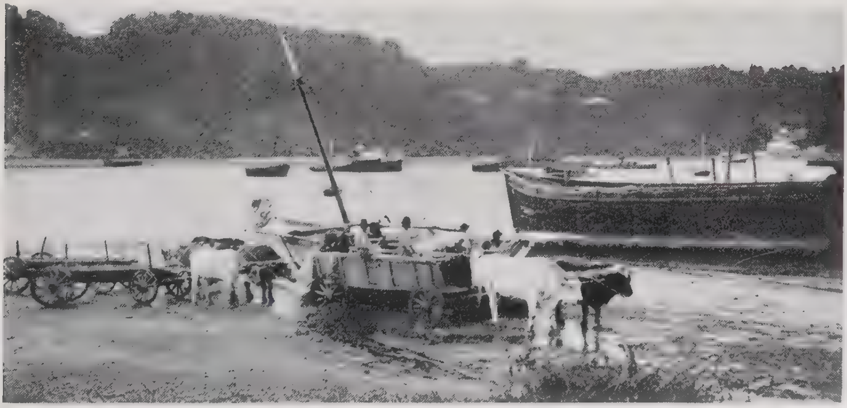

FIG. 14

FIG. 12—Looking eastward over Puerto Montt, capital of the new province of Chiloé.

FIG. 13—Looking westward over Puerto Montt.

FIG. 14—So great is the range of tide at Puerto Montt that boats may be loaded and unloaded at low tide by oxcarts.

thousands of tons of sardines and anchovies are washed ashore by the waves, to be preyed upon by sea birds. Mackerel are also plentiful. Of shellfish there are quantities of oysters and *choros*, the latter being the Chilean mussel. A whaling company has been operating at San Pedro Island, southeast of Chiloé, for some years.

Canning has been done on a small scale at Calbuco and a few other places, but such establishments are all too inadequate. Meanwhile one finds canned fish from Europe and North America upon the shelves of nearly every grocery store in the republic. Such has been the condition for years, while the island province was vainly petitioning the government for funds to install a modern fishing fleet and build canning and curing plants.

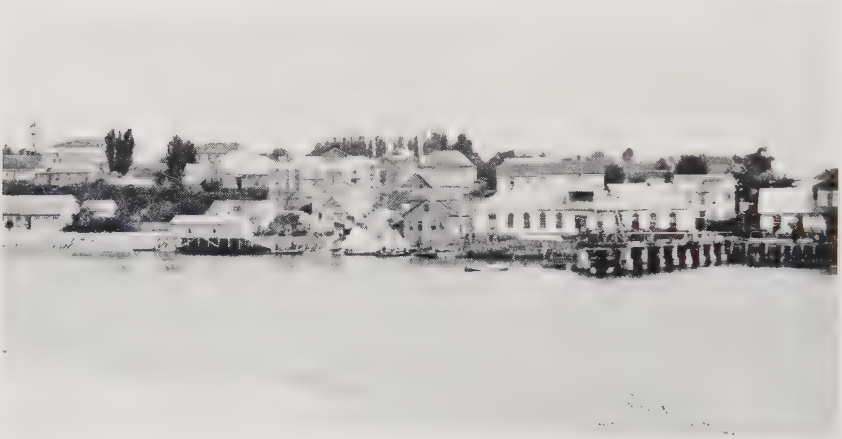

Fig. 15—Calbuco.

Settlements and Trade Routes

Although colonization under the Spaniards began in the sixteenth century, it is only within the last 75 years that important communities have been built up.[9] The population of the *departmento* of Llanquihue, Llanquihue Province, increased from less than 7000 in 1865 to over 43,000 in 1920. Puerto Montt, the new capital of Chiloé, was founded by Vincente Pérez Rosales in 1853, its first population consisting of sixty German families. The early name, Melipulli, was changed in order to honor President Montt, during whose administration the city was settled. Its bay is well protected by islands, forming one of the safest harbors in Chile. The city had 10,200 population in the census of 1920.

Of the smaller settlements, none number over 5000. Calbuco is a port upon an island founded by families fleeing from the Indian attack which destroyed the city of Osorno in 1604. Fishing and lumbering are its industries.

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[9] *Ibid.*, p. 23.

The island of Chiloé shows a much slower rate of increase: for the entire island from 59,000 in 1865 to 110,000 in 1920. The attempt at foreign colonization made toward the end of the century met with little success.[10] On the other hand emigration has been a problem. This is in part periodic, a large number of Chilotes going to the mainland in the spring for work in the agricultural settlements of Llanquihue and returning in the winter. Pierre Denis cites the case of the archipelago of Quinchao, east of Chiloé, in which, thanks largely to temporary emigration, a population of 50 to the square kilometer is supported.[11]

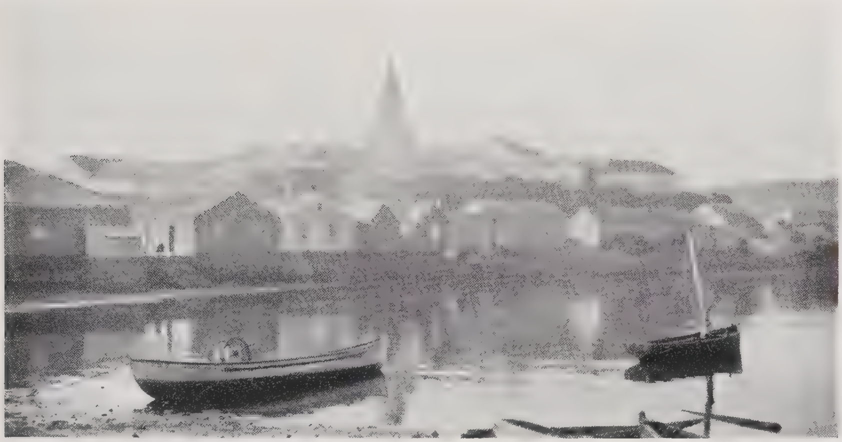

Fig. 16—Ancud, from the mole.

Ancud, former capital of Chiloé, was known as San Carlos (de Ancud) when visited by Darwin in 1834. The port ships potatoes, woods, and sea food. The city had 4295 inhabitants in 1920, of whom, according to Martin,[12] 242 were German. There was only one motor car in town when I visited there in 1926. On June 7, 1927, Ancud was crossed by a hurricane which destroyed the poor section and caused other damages.

Castro, the earliest capital of Chiloé, was described by Darwin as "forlorn and deserted" in 1834: it now has some 2700 inhabitants. The town is at the southern end of the new railroad serving the northern portion of Chiloé island. It has a good harbor and bids fair to attain some importance as the fisheries are developed. Achao is another small port situated upon the island of Quinchao.

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[10] See Mark Jefferson, Recent Colonization; also Jorge Schwarzenberg and Arturo Mutizábal: Monografía geográfica e histórica del archipiélago de Chiloé, Concepción, Chile, 1926.

[11] Pierre Denis: Amérique du Sud, Part II, Paris, 1928, p. 363.

[12] Carl Martin: Landeskunde von Chile, 2nd edit., Hamburg, 1923; reference on p. 738.

It is safe to say that prior to colonization of the last 75 years, travel in the province was mostly confined to waterways of the sea. Two railroads have since been built, one connecting Puerto Montt with Santiago as the southernmost link of the Longitudinal Railroad of Chile, and the other between the ports of Ancud and Castro. Both are operated by the Chilean government. Wood is the fuel used.

The railroad on the island of Chiloé is of two-foot gauge. The fastest train on its schedule covers its 53 miles in slightly less than five hours. Still this line has been an important factor in developing the interior of the island, its principal cargo being potatoes, woods, and hogs.

The line to Puerto Montt, of five-and-a-half-foot gauge, was completed in 1913. Lumber, cattle, and farm products comprise its principal freight. This line has also made accessible to dwellers of the central cities the scenic district of Lake Llanquihue, a large summer colony having been built up at Puerto Varas. Passenger traffic on this line has been increased in recent years by travelers from other countries, attracted to southern Chile by the natural beauties which have earned it the name "the Switzerland of America." A prominent North American syndicate recently made arrangements with the Chilean government for building hotels in the Lake Llanquihue district to provide for the travelers who visit here in increasing numbers each summer.

Subsidiary to the railroads is the commerce upon the lakes. That upon Llanquihue has assumed important proportions. Another navigable waterway is the Maullin River. This river, which drains Lake Llanquihue, may be ascended for 26 miles by vessels drawing up to nine feet, and several miles farther by smaller boats. It serves as an outlet for timber in large quantity.

Roads have been built to connect points between which there is no water route. Most of these are for oxcarts, although a few have been adapted to motor car traffic.

In recent years a new transandine route has been developed to connect the Chilean and Argentine railway systems. On leaving the Longitudinal Railroad at Puerto Varas, travel is by small boats and motor cars to Casa Pangue, thence by horses and mule-pack train across the frontier to the Argentine lakes. Boats and motor car lines in Argentina connect with Neuquen, from which point the rails are continuous to Buenos Aires. This route took on importance during the winter of 1926, when the Transandine Railway was blocked for some months by snow. Travel was possible by the Lake Llanquihue-to-Argentina route; for, whereas this crosses the Andes eight full degrees of latitude south of the railroad, the Pérez Rosales Pass (3445 feet) is low enough to escape heavy snows. Furthermore, neither the Chilean nor the Argentine lakes freeze during the winter months. The fact that this is an all-year-round route should make it desirable for travel. It may possibly develop some economic importance, although there are more advantageous crossings of the Andes farther north.

A Region for Exploration

There is no better way to conclude these notes than to mention the great lack of knowledge of the province of Chiloé. Much of its territory is within one of the portions of the earth's surface of which comparatively little study has been made, although it is a region worthy of further exploration both from the standpoint of industrial economics and of science. That no mines have been exploited in the province thus far seems odd, for its rock formations are quite similar to those in which Chile's vast copper deposits and other ores have been discovered. Auriferous beach sands found along the shores of Chiloé Island would indicate that there are perhaps placer deposits of gold in the region which have survived glaciation. For years inhabitants of this island have known of the existence of platinum in beach sands in the far southern section of its western coast—white gold they called it, without realizing its value.[13] An English company was recently organized to investigate and to exploit the platinum resources believed to exist.

Although it is nearly a century since Darwin visited and wrote about Chiloé, comparatively little has since been added to our knowledge of this interesting region.

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[13] Fritz Mella: El Platino en las arenas negras de Chiloé, *Riqueza Minera de Chile*, Santiago, November, 1927, p. 199.

LITTLE DIOMEDE ISLAND, BERING STRAIT*

D. Jenness

National Museum of Canada

THE two Diomede Islands, Little and Big, situated in the middle of Bering Strait, have been for countless ages the stepping-stones from Siberia to Alaska, from Asia to America. The easternmost point of Asia, East Cape, is but twenty-one miles from Big Diomede Island; the westernmost point of America, Cape Prince of Wales, twenty-two miles from Little Diomede; and the distance between the two islands is a scant four miles. On a clear day, Asia and America lie within mutual view, and the Eskimos cross from one continent to the other in their small skin boats, quite unconscious that they are bridging the gap between the world of the Orient and the world of the Occident. As they cross today, so their ancestors crossed a thousand years ago and a thousand years before that; for, without a doubt, Bering Strait has been one of man's principal routes from Asia to America since the close of the glacial epoch.

The United States Revenue Cutter *Bear* landed me on Little Diomede Island on July 26, 1926, and a small launch from the mainland picked me up on August 20. During the interval I excavated some old house sites and rubbish heaps in an attempt to unravel the history of its habitation. The temperature was very low for midsummer, the maximum reading of the thermometer being 45° F. (70° in the sun); and the island was frequently swept by driving banks of fog. With my Eskimo workmen I spent two days on Big Diomede Island also but was precluded from further visits by strong gales from the south. August and September are stormy months in Bering Strait; and, though ships can find shelter between the islands on either the north or the south side according to the direction of the wind, the rocky shores often make landing impossible. Navigation opens in June and closes early in October; but communication with the mainland is very uncertain. Besides the Revenue Cutter *Bear* and the Bureau of Education's schooner *Boxer*, each calling once or sometimes twice during the summer, there are only one or two small trading boats that drop in during a slack period to barter for walrus ivory. You may easily arrange to be landed on Little Diomede Island in July or even in June; but whether you will be fortunate enough to escape from it again before winter, is sometimes doubtful.

Little Diomede, which is nearly two miles long by over a mile wide with its axis running roughly north and south, rises steeply from the water's edge to a plateau 1300 feet above sea level. Formerly it was a huge crag of granitic rock containing tabular masses of recrystallized limestone; but the limestone weathered, and the crag broke down into a mass of breccia, leaving steep precipices at various places along the shores. There is only one landing place, a narrow beach of waterworn boulders three hundred yards long on the southwest side of the island, where the mountain dips a little more gently towards the sea; and even this is covered by breakers in stormy weather. The native village lies on the slope above, a motley collection of stone huts with frame porches strewn on either side of a narrow pathway, wherever the ground is sufficiently level to furnish a foundation. Above the village, among the breccia of the hillside, is the graveyard. Tradition states that in ancient times the graveyard was on the site of the present village and that the old village lies beneath the water; a native fishing off the point, it is said, once drew up a roof beam on the end of his line. Certainly the water is shallow halfway from the village to Big Diomede, and the coast line seems new, the cliffs showing no marked signs of erosion. Yet, if a subsidence has occurred, it must have been purely local or else long before any memory of its occurrence. At Wales, 22 miles away on the mainland of Alaska opposite, there is definite evidence that the coast has been stable for several centuries and probably very much longer. At that place a small stream rushes down a ravine in the mountains, turns almost directly back on its course when it reaches the tundra, and slowly meanders for a mile before it bisects the modern village on the shore and enters the sea over a shallow bar. About 100 yards back from the beach (200 yards following the meanderings of the stream) it skirts a low mound containing the ruins of ancient houses, inhabited, the natives say, when the stream could be navigated to their doors. The floors are three feet below the surface, and both their depth and their contents indicate an antiquity of at least four or five hundred years. Evidently the coast has remained stable since their occupation, but the shore line has slowly extended outward. Since the entire plain is uniformly but a few inches above sea level and is underlain by beach sand back to the talus slope, it must have arisen from similar deposition, and the coast must have continued stable

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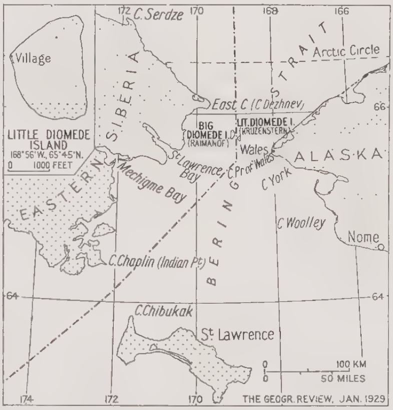

FIG. 1—Map showing the position of the Diomede Islands. Scale 1:9,000,000.

throughout the whole period of its formation—a period doubtless covering several thousand years. If there is any truth at all in the native tradition about the sunken village off Little Diomede Island, the explanation may lie with the ocean current, which sweeps between the two islands, generally northward, at a rate of from two to five miles an hour, so that in the lapse of centuries a low promontory may conceivably have been scoured away by the combined action of ice and water.

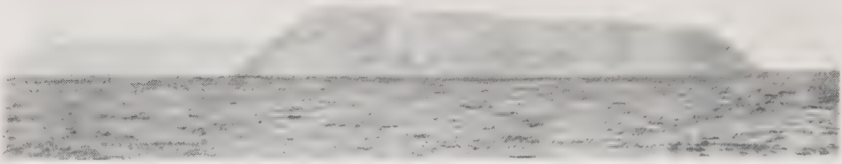

FIG. 2—Little and Big Diomede Islands, from the east.

VEGETATION AND ANIMAL LIFE

Mr. A. E. Porsild and his brother, botanists attached to the North West Territories and Yukon branch of the Canadian government, joined me during my last week on the island and made a thorough survey of its land flora, in the hope that it might throw some light on the problem of a possible land bridge between Asia and America since Pliocene times. Mr. Porsild collected eighty-six species of flowering plants and mosses and more than a hundred of lichens, which he proposes to identify and study in the near future. In the meantime he has kindly furnished me with the following brief note:

> The flora of Little Diomede, even though it exceeds the land fauna in the number of species present, yet shows remarkable deficiencies when compared with the flora of the mainland on either side of the strait or with that of the large St. Lawrence Island to the south. This is due, of course, to its distance from the mainland, the unfavorable climate, and the scarcity of soil. On the precipitous slope to the south and west, where millions of birds nesting through the centuries have filled the spaces between the rocks with manure, the ground is covered in some spots with a luxuriant growth of grasses and cotton sedges. Here abounds also the "Eskimo potato," a Claytonia, probably endemic, with a white, rather inconspicuous flower and a root, greatly relished by the Eskimos, that attains in fertile soil the size of a large walnut. The pretty pink Claytonia and the blue monkshood form extensive patches in sheltered places.
>
> The frequent fogs and rains and the abundant supply of manure promote the growth of many lichens that cover the rocks in thick crusts. On the slope the brilliant Xanthoria and Cetrarias help to brighten the gray rocks; but the black Alectoriae that predominate over the plateau on the summit of the island make the landscape seem bleaker than if all vegetation were lacking.

A few foxes and white bears visit the Diomedes during the winter, and once within the memory of the natives a lemming was caught on

Little Diomede. Apart from these there are no land animals, not even mice. Marine life abounds. Killer whales (*Orca gladiator*) are not uncommon, and walrus and bowhead whales (*Balaena mysticetus*) pass by in large numbers both in spring and fall. Many beluga (*Delphinapterus catodon*) migrate northward between the two islands when the ice breaks up, but most of them pass to one side or the other at the close of the brief summer. Of seals there are four species—the hair (*Phoca hispida*), bearded (*Erignathus barbatus*), harbor (*Phoca richardii pribilofensis*), and ribbon (*Phoca fasciata*). The ribbon seal is scarce, the harbor seal becomes plentiful only in August and September, but hair and bearded seals frequent the islands throughout the year. The natives catch many sculpins and crabs and a few polar cod, but they give little attention to fishing.

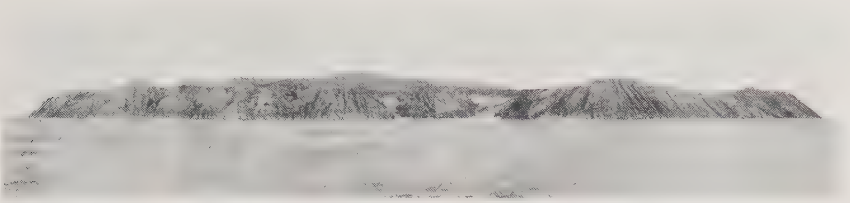

FIG. 3—Big Diomede Island, from Little Diomede Island.

Land birds too are few. A snowy owl was seen; in place of mice it preys upon the eggs and young of sea birds. And there were the ubiquitous snow buntings. A wader occasionally lingers along the beaches. The natives shoot a few eiders or catch them occasionally with the bolas; but neither eiders nor old squaw ducks are plentiful. Several black-throated loons flew by, or settled on the water, during my stay; the yellow-billed loon rarely visits. Yet the islands are not deserted. Every cliff is a nesting ground for murres, cormorants, kittiwakes, puffins (two species), and another bird I could not identify; and auklets, flying in clouds like mosquitoes, darken the sky.

LITTLE DIOMEDE VILLAGE

With the exception of a Norwegian missionary and his wife the only inhabitants of Little Diomede were Eskimos. Many of them wander to Nome and elsewhere during the summer, but they nearly always return before winter. A census at Christmas, 1925, placed their number at 94; when Kobelev landed on the island, in 1779, it was 160.[1] As in many other places, the Eskimo strain here is not pure; one or two natives show traces of white admixture, and several almost certainly have Chukchi blood in their veins. Yet the dialect is so typically Eskimo that a native from Greenland could converse with the Diomede Islanders with little difficulty after a few days' contact.

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[1] P. S. Pallas, in *Neue Nordische Beyträge*, Vol. 4, 1783, p. 107, St. Petersburg and Leipzig. The population of Big Diomede Island at the same date was 398; now it is reduced to six or seven families. The Russians first sighted the Diomede Islands in 1730 but did not visit them until 1732 (F. A. Golder: Bering's Voyages, Vol. 1, *Amer. Geogr. Soc. Research Ser. No. 1*, 1922, pp. 21–24).

The village itself is of an unusual type, even in Alaska. The houses, ten in number, are built of beach-worn stones laid one above another with only earth for mortar. Inside they are sheathed with rudely dressed planks, but that is apparently a modern innovation; in former days only the floor and gabled roof were of planks, and on the roof these were often replaced by whale ribs. Most of the houses now have frame porches, sometimes quaintly two-storied, on the same ground level; but two still preserve a long dark passageway of stone on a lower level, with whale ribs framing the entrances. The visitor stumbles with bowed head along the ill-laid boulders, steadying himself with one hand against the greasy walls; and, after groping thus for about ten yards, suddenly straightens up and pushes his head and shoulders through a round hole in the middle of the floor. The room is square, with wide shelves the length of the walls along three sides and a skylight of walrus intestine. The family or families, for there are two in each of these houses, sit around on the floor, the men perhaps carving ivory, the women sewing or boiling a pot of meat over the seal-oil lamp; for, owing to the scarcity of wood, blubber remains the principal fuel. Two or three children probably sit on a shelf, dangling their legs over its edge.

The interesting feature about these houses is that nowhere on the American continent, outside of Greenland, do any Eskimos live in houses quite similar. Yet there are ruined dwellings of much the same type throughout the Arctic Archipelago, around the shores of Hudson Bay, in Baffin Island, and even in Labrador. In all these regions, as on the Diomede Islands, driftwood was too scarce to permit of the substantial wooden houses that were erected by the Eskimos of the mainland from the Kuskokwim to beyond the Mackenzie River delta; the natives therefore had recourse to stone. But in the central Arctic, from Coronation Gulf to Labrador, snow huts, apparently a local invention, superseded huts of stone several centuries ago, and the latter survive in use only on the fringes of the Eskimo area—in northern Greenland on the one side and on the Diomede and King Islands of Bering Strait on the other.

ARCHEOLOGICAL RELATIONS

The parallel in the dwellings becomes still more significant when we consider the remains that have been found in the old stone houses of northeastern Canada and compare them with the remains unearthed in Alaska. One naturally expects to find some differences throughout so wide an area, with resources varying from one region to another;

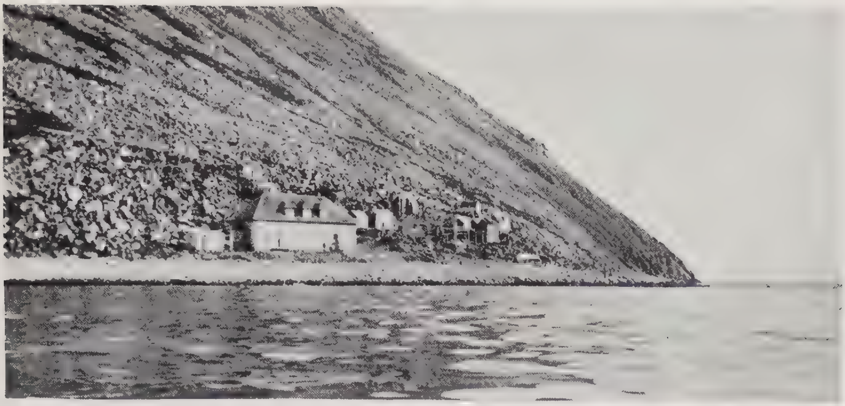

Fig. 4

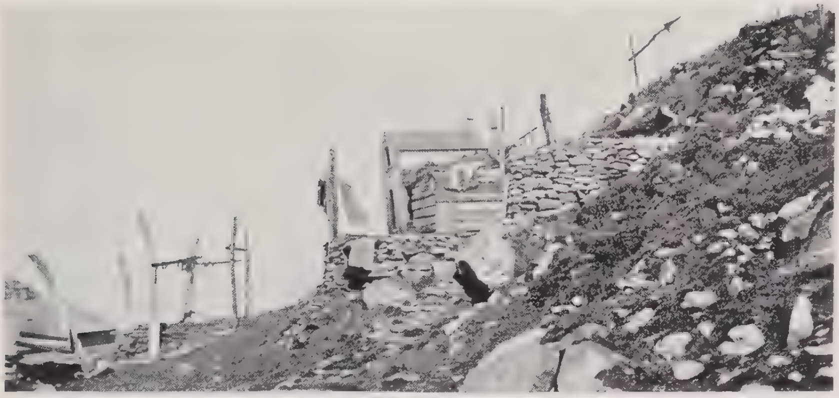

Fig. 5

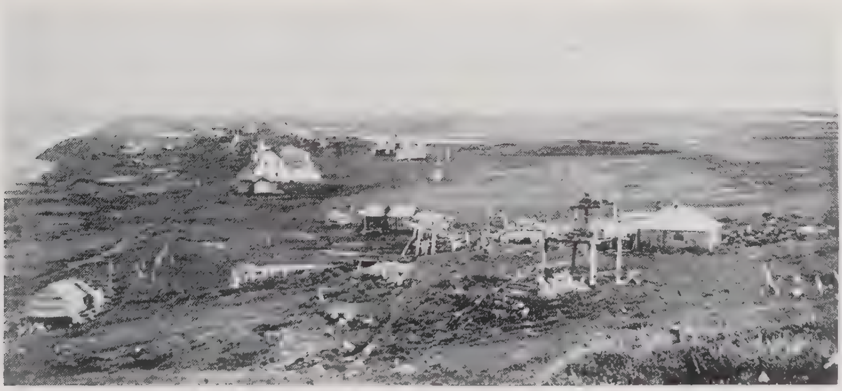

Fig. 6

Fig. 4—The landing place and village on Little Diomede Island. Note the breccia on the mountain slope.

Fig. 5—Stone houses with two-story frame porches on the ground level, and stone passages below.

Fig. 6—Wales, the nearest point of America to Asia. In the background, on the right, lies the mound where the ancient inhabitants built their houses.

yet, broadly speaking, the remains from the two regions are so remarkably homogeneous that they plainly represent a single culture. This culture, called Thule by the Danish archeologist Mathiassen, extended several centuries ago from one side of Arctic America to the other. In Alaska—at least from Bering Strait northward, for the archeology south of this region is but little known—it has changed very little and by slow stages only; but in northeastern Canada it seems to have been suddenly superseded by a culture considerably different and in many respects more primitive.[2]

The slightness of the change in Alaska was less easily observed on Little Diomede Island than at Wales, owing to the greater difficulties of excavation. The space available for habitation being limited, the natives had erected and re-erected their dwellings on the same sites, and most of the ancient houses were concealed beneath the modern. Others were buried beneath huge boulders that had rolled down the mountain side. The few sites that lay exposed, principally rubbish heaps in front of the dwellings, the Eskimos themselves had overturned to a depth of two or two and a half feet in order to recover the fragments of fossil walrus ivory, which they fashioned into beads and paper knives or sold to traders at $2.50 a pound. The ground was frozen four inches below the surface and, when stripped to frost level, thawed out at a rate of less than two inches a day. Altogether the conditions for archeological work were much less favorable than they had been on the mainland a month earlier, so that only five sites (two imperfectly) were excavated on Little Diomede Island as compared with twelve at Wales. The remains from the two places, however, supplemented each other, and, taken together, throw an interesting light on the earlier history of this portion of Bering Strait.

In some of the more recent ruins at Wales the floor level lay at a depth of from 12 to 18 inches below the general surface of the ground; and two glass beads, with a few fragments of iron, showed that there had been indirect contact with European civilization. Since the Russians reached Anadyr, in northeastern Siberia, in 1649 and soon afterwards explored other parts of the Chukchi Peninsula, introducing iron and beads among the inhabitants, these houses at Wales, which has always been in close contact with the settlements across the straits, can hardly date later than 1700. On a mound in the tundra behind them was another group of ruins which contained neither iron nor beads and which had floors three feet below the surface; but, although these dwellings must have preceded the others by several centuries, the specimens from the two groups of ruins were for the most part indistinguishable. The older ruins had sealing harpoon heads with open sockets only; the later contained both open-socketed heads and heads with closed sockets like those in use today. The newer ruins, too, contained pipes and fish nets, both of which were absent in the older houses. Apart from these few details, however, there was no indication that the culture of the Eskimos had undergone any material change from the remote period represented by the mound dwellings down to European times. In post-European houses and graves there were stone lamps and grappling hooks for retrieving seals shot at the edge of the ice during the winter and early spring; but the stone lamps were brought from northern Alaska only after 1800, for the older remains contain lamps of pottery alone. The grappling hooks are still more recent, having been introduced within the last fifty years by the Chukchi and Siberian Eskimos who cross the strait each summer to trade on the Alaskan side. It was interesting to find labrets, and also implements for making seal nets and snowshoes, in the mound dwellings at Wales, for these also have sometimes been considered of modern origin. Seal nets, indeed, were known to ancient Eskimo tribes in Greenland, but snowshoes and labrets never extended beyond the Mackenzie River delta.

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[2] See Therkel Mathiassen: The Archeology of the Central Eskimos, *Geogr. Rev.*, Vol. 15, 1925, pp. 544–549; also in Report of the Fifth Thule Expedition, 1921–24, Vol. 4, Copenhagen, 1927.

Before the occupation of Alaska by Europeans, both the Diomede Islands and Wales were far more closely connected with Asia than with America. Flint and serpentine, so common in ruins at Point Hope and Barrow, were comparatively scarce, especially on the Diomede Islands, indicating infrequent contact with Eskimos to the northward. It was from Asia that the inhabitants of the straits acquired the iron, beads, pipes, and fish nets that appear first in the ruins of two centuries ago. Local legends still tell of frequent battles with natives from the Asiatic shore, even of a flight of Eskimos from Wales to Barrow. On the east face of Big Diomede Island are two stone houses a hundred feet above the sea, erected two or more centuries ago at this inconvenient level for no other reason, apparently, than to escape raiders from across the water; and on the mountain slope east of Wales many huge stones were set up on edge to shield the warriors from the arrows of their enemies. The ruined dwellings at Wales and on the Diomede Islands tell the same story; for nearly every house, however deeply buried beneath the soil, contained breastplates of ivory or antler that were worn in rows as armor against attack.

Different from any of the specimens excavated at Wales, even in its mound dwellings, were a few objects recovered on Little Diomede Island. Unfortunately, only one, a harpoon point, was found *in situ*, that is to say, in what seemed to be undisturbed soil 8 feet below the surface. A second specimen, the broken foreshaft of a harpoon, lay almost on top of an overturned rubbish heap beside the schoolhouse. The remainder were purchased from the Eskimos, who had discovered them when digging for fossil ivory or excavating caches to store their meat. All these objects were inscribed with fine scrollwork altogether unlike the usual Eskimo carving or indeed any carving known in America; and the harpoon point differed in type from those at Wales, although others like it have been collected, without information, at three or four places along the Alaskan and Siberian shores.[3] There can be little doubt that these specimens belong to a separate culture in this region, a culture, to judge from the depth of the harpoon point below the surface and the absence of similar remains in the mound dwellings and later ruins at Wales, of greater antiquity than the widespread Thule culture. The elucidation of its details, however, and the determination of its origin, age, and relation to the Thule culture all await further archeological researches, not, perhaps, on the Diomede Islands, where the difficulties of excavation are considerable, but along the mainland shores on both sides of the Bering Sea and on the large St. Lawrence Island within its basin.

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[3] For illustrations of three of these specimens see "Problems of Polar Research," *Amer. Geogr. Soc. Special Publ. No. 7*, 1928, p. 171.

DAILY MAPS OF WORLD WEATHER

AN ATTEMPT AT THREE-DIMENSIONAL GEOGRAPHY

Alexander McAdie

Blue Hill Observatory

FOR half a century forecasts of weather have been based upon synoptic maps, that is, maps on which are charted simultaneous observations made over the area under jurisdiction of any one nation. Since the area charted should be as large as possible, international coöperation is needed. This is the object of the Commission for Synoptic Weather Information first organized in 1909.[1] At a meeting in London, May, 1928, the Commission considered methods for obtaining, transmitting, and charting definitive data. Action was taken regarding the adoption of a universal code and the making of observations on all oceans at standard times. It was voted that hereafter pressure readings should be expressed if possible in modern units of force, that is, in millibars. The use of an international temperature scale remains for a later conference. Land reports, of course, are easily obtainable from national services. Radio permits us to get data from over the ocean. It is proposed, among other things, that the main collecting and distributing center for the North Atlantic be at the Azores. But the resulting map must be something far different from present surface, or two dimensional, maps. The atmosphere has three dimensions; and the geography of the air—or, as we may well call it, airgraphics—requires the delineation of conditions at various levels as well as at the surface. We are entering an era of utilization of the air for transportation and communication, and a fine field for exploration and survey it offers.

PRESSURE DISTRIBUTION AND FORECASTING

On our present synoptic maps areas of high and low pressure are marked by logotypes; and the storm track is determined by joining up from day to day the positions of lowest pressure. This assumes that minimum pressure is the true center of air movement, which may not be the case. Hence we have some erratic tracks. When the data are entered and pressure areas defined, the forecaster bases his judgment upon a well known general law, viz: "That a well defined

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[1] The history of this Commission is briefly stated in the "Report of the Sixth Meeting, Zürich, September 9–16, 1926," *Meteorol. Office Publ. No. 293*, London, 1927. See also abstracts of reports of subsequent meetings given in the *Meteorol. Mag.*, August, 1928; and in the *Monthly Weather Rev.*, July, 1928.

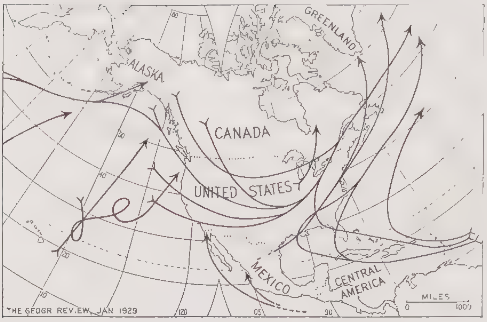

FIG. 1—Storm tracks over North America and adjacent waters. (The projection is Cahill's: scale 1 inch = 1000 statute miles: equal area: errorless parallels: central meridian in each octant rectified.)

cyclonic depression in temperate latitudes will drift to the east at a rate varying with the time of the year, the intensity of gyration, and the intensity and area of the anticyclone immediately in advance." Other causes not preventing, the rotating mass of air will be deflected to the right in the northern hemisphere, owing to the earth's rotation; but, because of the mean gradient of pressure, it will have a northward trend. Forecasting is based mainly upon this expectation of an eastward and somewhat northeast "travel" of the depression. Anticyclones, or regions of high pressure, tend to drift to the southeast.

For many years attention was centered on the "low"; but it is now well recognized that the anticyclone plays the major rôle and determines the onward march if not indeed the development of the low. Some general paths of storms, airways in the best sense of the word, are shown for the United States and bordering waters in Figure 1, covering nearly half of the northern hemisphere; a decided improvement on existing maps, for as matters now stand, owing to the distribution of duties incident to two different governmental bureaus, the Pilot Charts of the Hydrographic Office limit their storm tracks to the oceans, leaving to the Weather Bureau the paths on land. There is thus a break in the record, which necessitates the use of a new base map. A circumpolar map, not for general distribution, enables the forecaster to trace the life history of depressions that enter from the Pacific or from the Atlantic and either cross the continent or sheer off. A map of the northern hemisphere of this type can be found as frontispiece to Part IV of Sir Napier Shaw's "Manual of Meteorology," reproduced in

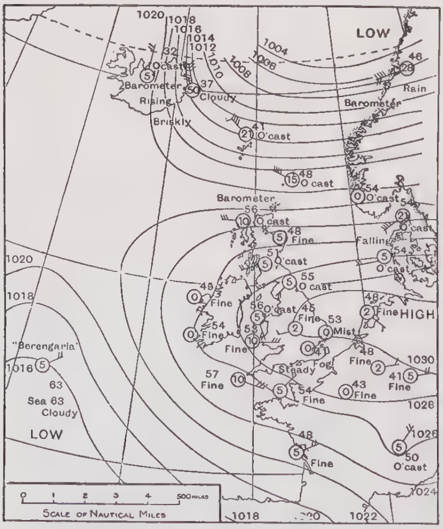

FIG. 2—On this chart, for September 28, 1921, a successful forecast of fair weather for 14 days was based.

the *Geographical Review*, Vol. 10, 1920, page 38. It would add greatly to the value of the present daily weather information if such a northern hemisphere map in reduced and convenient form, prepared jointly by the Hydrographic Office and the Weather Bureau, were made available.

It would moreover mark a decided step forward, if in addition to the storm tracks the intensity and travel of "highs" were shown. Not until this is done will the accuracy of forecasts be much improved. One advantage of such far-flung charting is that slow-moving "highs" are instantly noted and the forecaster may anticipate a consequent slowing down of the following "low." Incidentally it would encourage the forecaster to venture a long range forecast. For example, Figure 2 illustrates a forecast for 14 days in advance made in the Meteorological Office at 7 a. m., September 28, 1921.[2] No rain fell in London for two weeks. A forecast of much greater moment, however, might have been made at the beginning of October, 1924, for the eastern half of the United States (Figs. 3 and 4). It was evident that a steady inflow of polar air and an absence of warm moist southerly winds were leading to the building up of a "stagnant high," as it is technically called. That is, the hyperbar then resting over the eastern half of the continent was preventing the passage of both northern and southern "lows." Plainly the chances were all against a normal rainfall from the Mississippi Valley to the Atlantic, with the exception perhaps of Florida. As a matter of fact that month was the driest October on record, and some of the records ran back for 100 years. Figures 3 and 4 show clearly the interdependence of rainfall and pressure excess.

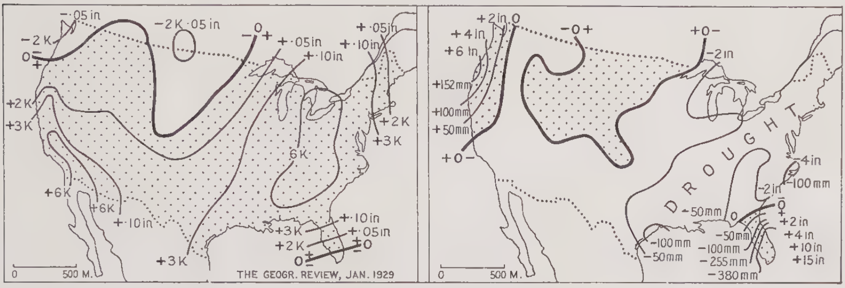

FIG. 3 FIG. 4

FIGS. 3 and 4—Drought conditions over the eastern half of the United States at the beginning of October, 1924. Figure 3 shows pressure excess in kilobars and equivalent hundredths of inch. Figure 4 shows rainfall deficit in millimeters and equivalent inches.

During the prevalence of the hyperbar (a stagnated excess pressure) "lows" could make no headway eastward; and, what is of direct significance, a tropical cyclone (or West Indian hurricane) could not advance north. The storm over the northwestern Caribbean

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[2] Sir Napier Shaw: Forecasting Weather, 2nd edit., London, 1923, p. 181.

Sea, October 13 to 18, was held in position, the usual resultant directive force toward the northwest being ineffective. The rotational energy was not diminished; and hence some of the lowest pressure readings ever recorded in that region, famous for low pressures at hurricane centers, occurred. A land station reported 932 kilobars (27.52 inches), and various ship reports indicated 950 kilobars or less (28 inches). The hurricane being thus in a measure stationary, the rainfall was unusually heavy. At Miami the total for the month was 635 millimeters (25 inches), or 400 millimeters (16 inches) above the normal rainfall for October. In the Porto Rican hurricane of September 12 to 20, 1928, we can trace clearly the influence of the "high" over the North Atlantic States in determining the point of recurvature and subsequent north and westward movement of the hurricane. We note also the heavy rainfalls along the coast from Florida to Virginia, owing to the blockade.

This hurricane has started discussion of the possibility of dissipating approaching storms by some sort of trigger action whereby the stratification incident to increase of thermal energy can be prevented or broken. Some idea of the magnitudes involved in the displacement of air masses in an ordinary depression can be obtained from the data given later in this paper. At present little more can be said than that, regardless of theoretical considerations, we have no means of interfering with or breaking up storm structures. The forces involved are so stupendous that the effort would be comparable to that of attempting to sweep back an incoming tide with an ordinary broom, or even many brooms. On the other hand we can detect the existence of conditions favoring the formation of a hurricane, and we do anticipate the path with a high degree of accuracy.

Relation to Flood Forecasting

A natural question arises at this point. Can this knowledge of the pressure-precipitation relation be used in forecasting floods as well as droughts? We think it can; but the problem is different, though essentially less difficult. A sharp distinction must be made between heavy rainfalls and floods. True, no flood can occur without a preceding heavy rainfall, but the converse does not follow. In a large drainage basin like that of the Mississippi an excessive volume of water may pass through the waterways without damage or culminating in overflows, provided various factors operate in unison. The memorable floods in the Mississippi Valley in 1913, 1922, and 1927 were the result of saturated ground, previous heavy rains, flood crests in the northern tributaries, and a synchronism of the crests with heavy rains in the lower reaches. The breaking of protective levees and the formation of crevasses followed. It is estimated by

Frankenfield[3] that the total rainfall from January 1 to April 30, 1927, for the entire basin was 213 cubic miles. This is about a million tons of water, the bulk of which must hurry to the Gulf. If the delivery can be slowed down by means of storage basins and by-passes, overflows *can be prevented.* This water, however, was at some time lifted to a height of at least 1000 meters, which gives us a mental picture of the work done by air currents in the making of rain clouds. Sir Napier Shaw, it may be noted, has given an estimate of the energy in a depression over the North Sea, July 27 to August 3, 1917, thus: diameter of depression 1400 kilometers; depth at center 10 kilobars; quantity of air removed to allow for depression 70,000,000,000,000 kilograms; quantity of water vapor 700,000,000,000 kilograms, with resultant kinetic energy developed, 1.5×10^{24} ergs.

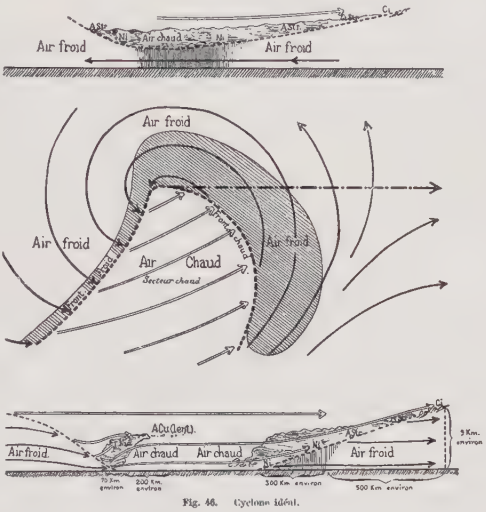

FIG. 5—Polar Front Scheme, for origin of cyclones. Bjerknes and Solberg.

THE UPPER AIR AND MODERN METEOROLOGICAL THEORY

This brings us to the problem of how best to record and interpret clouds, with the best presentation on daily weather maps. The fact that we now are able to determine the direction and speed of the air at cloud levels, ought to be of great assistance in the making of forecasts. Also a steadily increasing number of reports giving the temperature gradient with elevation—or, as it is called, the lapse rate—lets us sound the air, as it were, and map the upper strata.

European aerographers pay much attention to what is called the polar front. Both name and theory are due to Professor V. Bjerknes. This front is the surface of discontinuity between cold air from polar regions and warm air from the equatorial regions. "Lows," or depressions, develop at this surface. Cold air pushes forward under warm air, and warm air rises over cold air in its front. The general scheme is shown in Figure 5. The shaded part of the figure indicates the rain area. As Ernest Gold has said:[4] "The outstanding advantage of the theory is the light which it throws on 'development.' By its

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[3] H. C. Frankenfield: The Floods of 1927 in the Mississippi Basin, *Monthly Weather Rev. Suppl. No. 29,* 1927.

[4] Quoted in Sir Napier Shaw: Manual of Meteorology, Vol. II, Cambridge, 1928, p. 388.

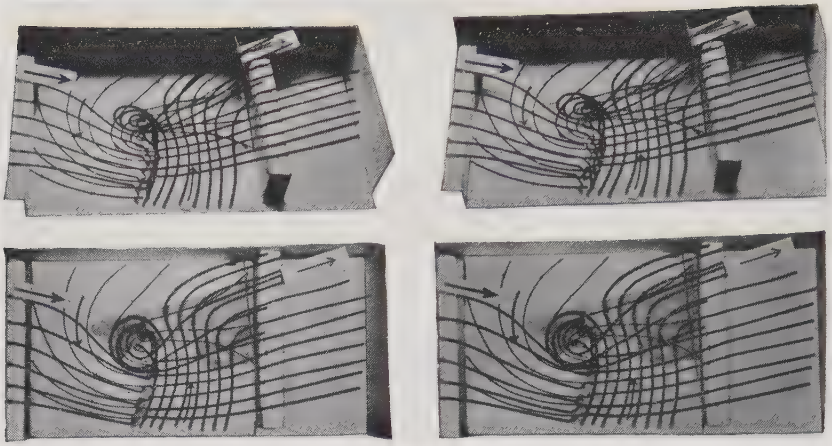

FIG. 6—An illustration from Sir Napier Shaw of the three-dimensional study of the air.

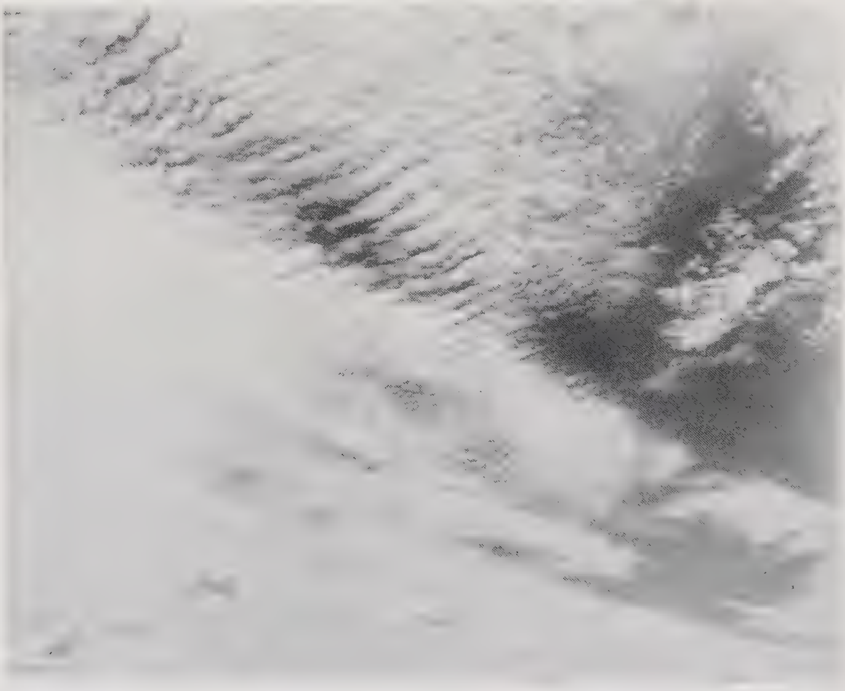

FIG. 7—Clouds showing stream lines in convection and stratification.

aid the forecaster can now see how an existing cyclone will develop; whether it will go on increasing in intensity, or if it will become stationary and fill up; he can also see where a new cyclone is likely to develop *before any actual development has commenced.*"

It is only fair to say, however, that, as tried in the United States, conditions do not always conform to what the theory demands. Unfortunately we have but little information about the rate of ascent of air, warm or cold, dry or moist; and until we get this "our ideas about the inner life history of a cyclone are necessarily crippled." "Our cyclones are cold in the core, cold-hearted creatures, not the warm-hearted figments of the meteorological imagination of the past 60 years, and that indubitable fact means that they had been formed before they reached us. It was unnecessary and therefore unwise to think of the processes which the meteorologists detected as soon as they had maps to work with, as being the agencies for the making of cyclones; we should have been better advised to think of them as agencies for the destruction of those creatures."[5]

Figure 6 is a photograph from a model showing stream lines of convection in a vortex superimposed upon a uniform current of air at the level of the fourth kilometer with a retardation of motion at the surface, thus "featuring" the cyclonic depression of November 11–13, 1901. This photograph was kindly sent to the writer by Sir Napier Shaw. It appears also in the "Manual of Meteorology," Volume II, page 405. The stippled area in the lower figures (rather faintly shown) indicates rainfall with reference to the center of the low at the surface. We are looking down on the stream line in the lower set, and at an angle of 30° in the upper set.

Figure 7 illustrates various air stream lines, both horizontal and vertical. The upper cirro-cumuli and alto-stratus have numerous small cumuli below, indicating that convection may occur with stratification.

From these examples it is obvious that certain additional data should now be presented on our daily weather map. We must reach upward as well as enlarge the horizon.

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[5] *Ibid.*, p. 404.

MAJOR WORLD SOIL GROUPS AND SOME OF THEIR GEOGRAPHIC IMPLICATIONS

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THE development within the last half century of a science, pedology, which deals with the soil as a natural body, has opened a vast area of uncorrelated geographic material. It is the purpose of this paper to indicate certain tentative landmarks therein.[1]

Although soil is one of the major elements of the environment and its importance is appreciated in a general way, its rôle has not been fully understood. It shares its influence upon plant life with climate and, since climate is more or less familiar and its effects are relatively easily understood, the real significance of the soil is often overlooked in the effort to set forth the climatic relationships. The soil, in contrast to the climatic environment, is extremely complex; and little was known until recently with regard to its fundamental characteristics. It had been studied largely from the standpoint of its relationships to the materials from which it is evolved and to the method in which these materials accumulate, but little or no attention was given to the properties of the soil itself.[2]

SOIL CHARACTERISTICS

Soils have chemical, physical, and biological attributes. Limits of space prevent any but the briefest references to several of the more striking key characteristics to which subsequent attention will be directed. These include color, structure, and certain chemical and profile phenomena. Texture is omitted, since the reader is undoubtedly familiar with the nature and meaning of this important qualification.

Soil colors, outside of identification, are often indicative of other significant properties, viz. the proportion of organic matter present, the tilth conditions, etc. They embrace two general classes: (1)

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[1] The facts here presented, upon which the geographic generalizations are based, represent the work of many investigators in addition to that of the writer—especially that of his coworkers in the U. S. Bureau of Chemistry and Soils as well as numerous soil scientists of other countries. The writer is chiefly indebted, however, to Dr. C. F. Marbut, whose keen and untiring mind built up much of the framework of modern soil science and whose generous personal concern in his field of interest has been a constant source of inspiration.

[2] H. L. Schantz and C. F. Marbut: The Vegetation and Soils of Africa, *Amer. Geogr. Soc. Research Ser. No. 13*, 1923, pp. 115–117.

dark colorations, such as blacks and dark browns, and (2) light colorations, the tints ranging through reds, browns, yellows, and grays. As a rule dark colorations characterize soil material high in organic matter, the black humus compounds masking the lighter mineral particles.[3] Such soil material is usually fertile, is easily tilled, and has an abundant supply of nitrogenous substances. Light-colored material tends towards opposite characteristics, being low in humus and less amenable to good tillage. The light colors represent chiefly iron in several states of oxidation and reduction, commingled with small amounts of decomposed vegetable matter. Soil colors are usually acquired characteristics; in only exceptional cases are they inherited from the parent material.

Soil structure refers to the arrangement of the individual particles (clay, silt, and sand) as larger aggregates or bodies. A variety of forms are assumed—blocklike, cloddy, nutlike, granular, columnar, platy, etc.[4] Their geneses are also the results of soil-making processes, this feature being one of the more striking physical properties.

From the standpoint of agricultural economics the structural properties of soil material exceed all others in importance, especially in soils of heavy texture. Those of poor or imperfect structure are hard and refractory when dry, plastic and intractible when wet, and form lumpy, cloddy surfaces when turned in plowing. Their natural drainage is poor, and they are unresponsive to fertilizers. Soils with good structure, on the other hand, form smooth, crumbly seed beds, the upturned masses breaking down readily along the cleavage planes of the structural particles (Figs. 1 and 2). For instance clay soils, popularly classed as heavy and refractory, may crumble like sand, provided they have good structure. Some such soils may even be plowed when in a saturated condition.[5] These soils, moreover, have good internal drainage, as water easily penetrates the interstructural air spaces. As the majority of crops require well drained soils, the disposition of surplus water is necessarily important. The relationship of good structure to fertilization is of equal, if not greater, significance. Infertile soils with favorable structure may be profitably fertilized. Soils with poor structures, however, are unresponsive and, contrary to the prevailing belief, cannot be made productive by the mere addition of proper fertilizers. A favorable structure is more important than the presence of potash, phosphorus, and other so-called plant foods since structure appears to be extremely difficult, if not impossible, to correct, especially over large areas.

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[3] J. C. Russell: Variations in the B Horizon, *Rept. 8th Ann. Meeting Amer. Soil Survey Assn.*, pp. 100–113.

[4] The structural types were interestingly summarized by the Russian pedologist, S. A. Zakhorov, who presented a systematic classification to the First International Soil Congress.

[5] See, for example, "Sharkey clay," pp. 985–989 of F. Z. Hutton and Others: Soil Survey of Coahoma County, Mississippi, *U. S. Dept. of Agric., Field Operations of the Bur. of Soils, 1915* [*17th Rept.*], pp. 973–997.

Soil material of sandy texture is usually without structure, the unit particles being largely composed of single grains; but the deficiency is economically unimportant. This textural class is naturally very friable and usually possesses good internal drainage. Most sandy soils, moreover, appear to be responsive to fertilizers.

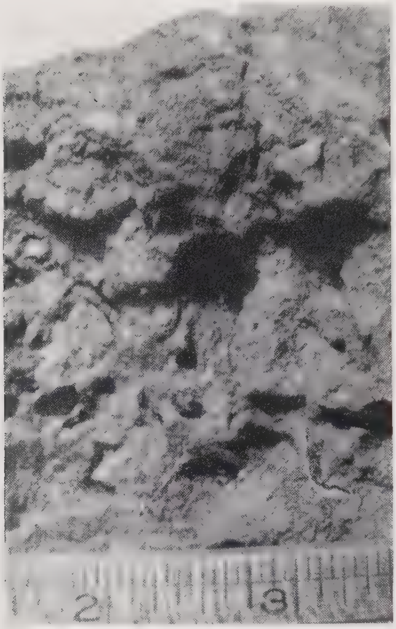

FIG. 1—A fairly coarse or nutlike structure of soil material, the shaded cavities indicating the size of the larger aggregates. When plowed the soil mass breaks down naturally along its cleavage lines. These fractures are also natural internal passageways for air, water, and roots.

The chemical characteristics of soil material may be viewed under two heads, reaction (acidity and alkalinity) and composition, although the former is a function of the latter. Acid soil materials are markedly unlike those of neutral or alkaline reaction. They are deficient in available bases, particularly calcium; their structure is coarse or imperfect; and fertilizers are essential for optimum crop-growth conditions. Soil materials of alkaline reaction, on the other hand, possess all, or a large number, of the more desirable soil properties.

While the more abundant constituents of soil material are the compounds of silicon, aluminum, and iron, the most notable component appears to be lime, or calcium carbonate. Important physical, as well as chemical, characteristics seem related to its absence or presence in comparative amounts. Soils low in lime are acid in reaction, while a high lime content is necessarily associated with alkalinity. Good structural development is also dependent upon the presence of lime, and, where conditions favor the accumulation and incorporation of appreciable amounts of organic matter in the soil, lime seems to be essential to its retention in the soil material.

Like other natural objects, soils show anatomical organization. The divisions are called zones or horizons, the terms being preferable to layer, as the change from one unit to another is usually gradational and not abrupt as in layers or strata. The peculiar nature and thickness of each horizon, as well as the features of its subdivisions, give a soil its character and constitute the bases upon which soils are not only differentiated from one another but are also distinguished from other earthy accumulations popularly referred to as soil. The latter do not constitute soil in the scientific sense because they are without the properties which characterize the great mass of those bodies covering the earth's surface.

The bases of subdivision into horizons are several. They include color, structure, texture, chemical composition, porosity, and other soil characteristics. The divisions with respect to any one property may or may not be identical with zones of another property, color zones often overlapping structural and textural horizons.

The normal soil profile reveals three major divisions—A horizons (soil), B horizons (subsoil), and C horizons (substratum) (Fig. 3).[6] The A horizons include the upper part of the soil mass from which material has been removed by percolating waters, in either a chemical or physical way, during the process of soil evolution. In humid climates these horizons are normally lighter in texture than the B horizons, are comparatively high in silica, and have a chemical composition wholly unlike that of the B and C horizons. Similar differences also exist in the soils of lower rainfall climates, but with less striking chemical and textural contrasts.

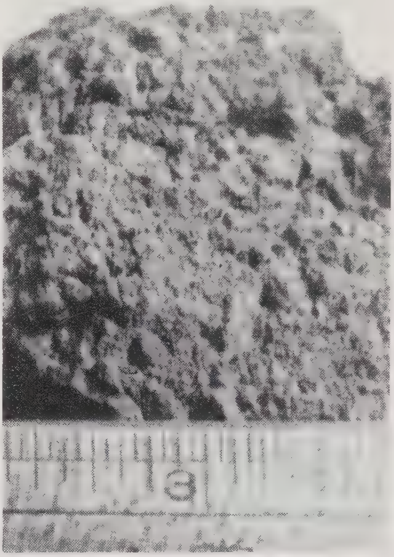

FIG. 2—The fine granular structure of one of the chernozems, southern Nebraska. The many small aggregates enable the mass to break down into the finest, smoothest seed bed. Root and water penetration are easy.

The B horizons are those of deposition, the zones to which material has been added by percolating waters. Those developed under humid climates are also low in alkalies and alkaline earths, but they are comparatively heavy-textured and high in certain iron and aluminum compounds. The C horizons comprise the relatively unweathered zones underlying the B horizons. The material, in most cases, is presumably similar to that from which the soil was evolved. It is often referred to as "parent material," but its chemical and physical properties are markedly different from the true soil or solum above it.

Evolution of Soils

The manner in which soils are evolved and the explanation of the characteristics they acquire are largely a concern of pedology. Geographers are interested, however, in the philosophy underlying modern soil science, as it serves to make clearer the soil's geographic relationships.

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[6] As the terms soil, subsoil, and substratum are somewhat loosely employed, soil science has adopted the letters A, B, and C for its divisions.

The belief that a soil's fundamental characteristics are inherited from, or closely related to, the parent material from which a soil was derived and the manner in which this material was accumulated, is a concept of long and almost universal standing. The assumption, in fact, is the basis for the several so-called kinds of soils—limestone, loessial, glacial, residual, etc., the modifier presumably indicating some notable characteristic of the soils in addition to the nature of the parent material. Limestone soils are supposed to be rich in lime; sandstone soils, poor and impoverished; alluvial soils, fertile and of good texture because "mixed."

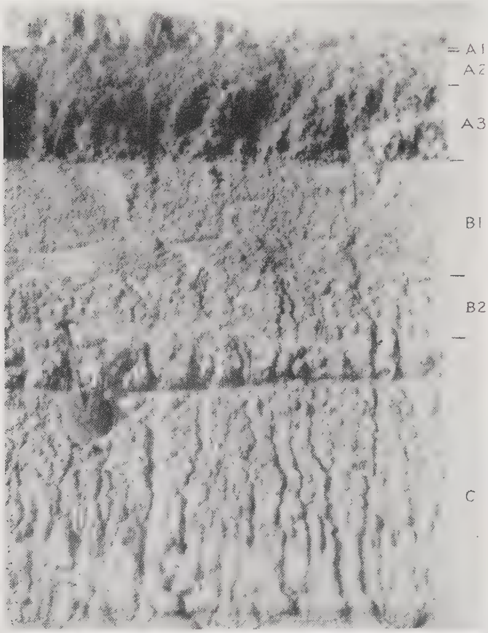

FIG. 3—Soil profile of the Hastings silt loam, one of the black earths, southern Nebraska, whose natural vegetation is long prairie grasses. The surface soil, darkened in color by decayed organic matter, has three subdivisions. A_1 horizon is grayish brown, structureless dust mulch, less than one inch in thickness, very fine sandy loam to silt loam in texture. A_2 horizon, about three inches in thickness, is made up of small, very dark grayish brown platy forms so disposed as to give the horizon a minutely layered appearance. A_3, dark grayish brown material, about eighteen inches in thickness, is characterized by granular structure.

The subsoil, or B horizon, has two divisions. B_1, the zone of maximum compaction, is not impervious, however, and is composed of grayish brown material markedly granular in structure. B_2, light grayish brown or yellowish structureless silt, is the zone of lime accumulation (white spots and splotches throughout the mass and soft or hard concretions).

The C horizon, or parent material, is silty, gray plains loess, generally without structure.

Field and laboratory studies do not confirm a general relationship between soil characteristics and parent material, however. The Hagerstown series, the dominant soils of the famous Shenandoah Valley and the Kentucky Blue Grass Region, for example, are derived from limestone; but they are not only benefited by lime applications but may also give acid reactions.[7] Large tracts of Mississippi's upland soils are derived from rich wind-blown loessial materials, but the soils are light-colored and acid. They have heavy compact waterobstructing subsoils. Fertilizers are used for corn and cotton, and the application of two tons of ground limestone per acre has proved beneficial.[8] In contrast are the loessial soils of central Nebraska and Washington.[9] Lime is accumulating in the B horizon, no fertilizers are used, and the normal soils are without compacted impervious subsoils. This type of discordance is general, not exceptional.

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[7] See, for example, "Hagerstown stony clay loam," pp. 450–451 of J. B. R. Dickey and W. B. Cobb: Soil Survey of Frederick County, Virginia, *U. S. Dept. of Agric. Field Operations of the Bur. of Soils*, 1914 [*16th Rept.*], pp. 429–472.

Of equal import is the widespread existence of great tracts of soils with similar fundamental characteristics, although derived from unlike geological formations. Glacial, loessial, and residual deposits constitute the dominant soil-forming materials in the upper Mississippi Valley, but great bodies of essentially like soils, with little or no regard to the underlying rock débris, have nevertheless developed. Differences of detail, of course, exist; but these dissimilarities are no greater than those prevailing among the land forms which the soils occupy or the natural vegetation which once mantled them. A convincing example is that of the *chernozems*, or black earths. These soils are not only widely separated but have developed from material accumulated in various ways and derived from many different kinds of rocks; yet their fundamental characteristics are the same.

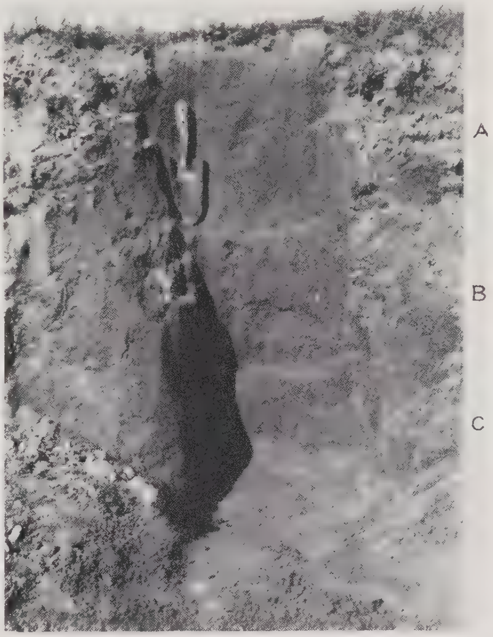

Fig. 4—A typical non-lime-accumulating soil, the Sassafras very fine sandy loam on the Delaware Coastal Plain. This soil belongs to the brownerths, the brown humid soils developed under forest covers. The excavated shelves indicate the depths of the several major subdivisions. There is no marked color difference between the A (soil), B (subsoil), and C (parent material) horizons; but the B horizon is compact and relatively dense, although sandy-textured. It consequently "holds back" water and is much more drought-resistant than soils composed largely of coarse, non-compact materials.

These soils are low in lime, nitrogen, phosphates, and potash but are heavily fertilized for trucking and fruit farming since they are close to urban markets. The compact B horizon is again an asset in that it prevents the over-rapid leaching of the costly fertilizers. As the C horizon is comparatively light in texture, the soils not only have the excellent underdrainage required by most truck crops but also dry out and become warm early in the spring.

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[8] E. Malcolm Jones and E. P. Lowe: Soil Survey of Alcorn County, Mississippi, *U. S. Dept. of Agric., Field Operations of the Bur. of Soils, 1921* [*23rd Rept.*], pp. 673–705; reference on pp. 688–689.

[9] See F. A. Hayes: Revision of the Grundy Series of Nebraska, *Rept. 8th Ann. Meeting Amer. Soil Survey Assn.*, pp. 86A–99. Dr. G. E. Condra, Director of Nebraska Surveys, is the leading authority on the loess formation of Nebraska. His recent findings and interesting conclusions regarding its origin are not yet published.

It is now recognized that the significant factors to which the basic features of soils may be attributed are the agents which further modify the accumulated materials from which the soils evolve. These produce physical as well as chemical changes. They bring about the decomposition of the minerals forming the rock waste. They effect the translocation of substances within the soil mass. They cause new structures, such as granules or nutlike bodies, to be formed. They develop the biological relationships of the soil. In short, they evolve a new entity—a body of matter quite unlike the original rock débris.

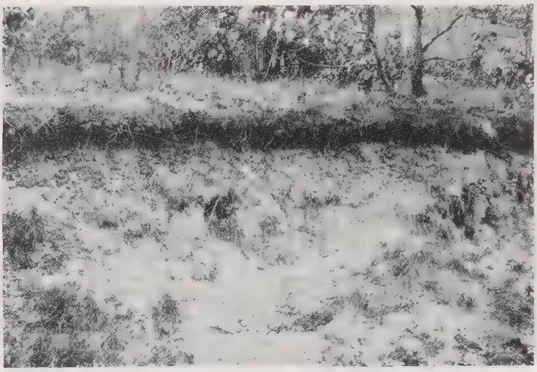

Fig. 5—Young Gloucester soil developing from coarse morainal deposits, Long Island, New York.

Climate is by all odds the most important factor, as it conditions, over large areas, the temperature and moisture under which the complex changes in the rock débris take place. The effect of other factors—the natural vegetation, the soil fauna, the land forms which the soil occupies, and others[10]—is secondary. The influence of the parent material is merely manifested, to any degree of importance, in its textural relationships, the clay and sandy types being derived from materials respectively low and high in silica.

Climatic Soil Groups

While soils are rarely uniform over extensive areas as respects minor features, yet great belts exist in which they have from few to many significant features in common. These soil groups are of peculiar interest to the geographer, especially in their larger connections.

The close relationship between soil and climate has brought about the development of great groups of soils whose distribution is roughly coincidental with the world's leading climatic types. The groups are not defined on the basis of their occurrence within the climatic regions, however, but on the characteristics which they themselves have developed, that is on the basis of soil characteristics and not on that of climatic phenomena.

The broad fundamental features of the soils of each group are essentially similar. As climate is the most powerful soil-forming agent and its conditions prevail over large areas, and since most soil-forming materials contain the same or equivalent chemical and physical compounds, extensive bodies of like material are subject to the same potent influence.

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[10] The rôle of climate and other factors which play important parts in soil evolution are to be the subject of a paper under preparation by the writer.

Each group has soils in various stages of development, however, owing to the influence of secondary factors; and appropriate age subgroups are recognized, such as young, mature, and aged. Young soils have rudimentary profiles (imperfect A and B horizons), are more or less like geological formations, and occupy hillsides and flood plains where they are subject to rejuvenation by erosion or deposition. Mature soils have well developed profiles, most of the chemical and physical changes to which they are subject having taken place. They are adjusted to their environment and occupy smooth, level areas where they are relatively undisturbed by erosion and deposition. Old soils typically evolve on flat surfaces where environmental conditions have long been stable. They have lost the essential features of maturity. Many soils in old age, for example, develop tough, indurated B horizons.

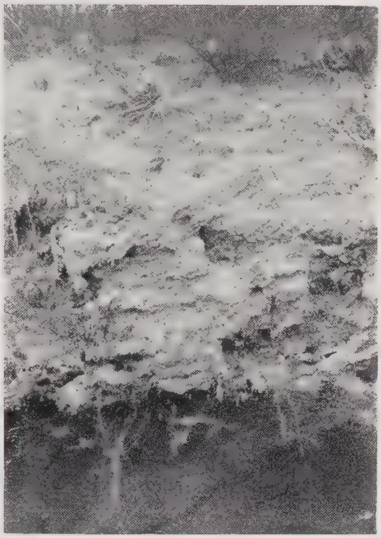

FIG. 6—A New England podsol. The A horizon is the light-colored—grayish, nearly white—zone, structureless and thoroughly leached. The B horizon is the dark-colored zone—brown or coffee-colored—in which iron oxide and organic matter have been precipitated.

THE MAJOR SOIL DIVISIONS

The great climatic soil groups form one of two major soil divisions[11]—those which have lime accumulations at maturity and those without such accumulations, these features being curiously developed regardless of the nature of the parent material from which the soil was derived. The former have some zone, usually the lower part of the B horizon, in which lime appears in greater proportion than in any other division of the profile. The latter group has no horizon in which calcium carbonate accumulates. In fact, the typical mature soils are low in lime and acid in reaction. They normally develop under forest covers, the lime-accumulating group occurring under grassland and desert associations. These major soil divisions are analogous to the plain-plateau and mountains of physiography, the flowering and nonflowering plants of botany, or the vertebrates and invertebrates of the animal world. They are characterized by a simple and easily recognized feature—the absence or presence of a zone of lime accumulation.

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[11] A comprehensive scheme of soil classification has not yet been perfected and generally adopted. Dr. C. F. Marbut, however, has proposed an admirable system embracing seven categories, each division of which is based not on genetic relationships but upon the characteristics of the soils themselves. See Bennett and Allison: The Soils of Cuba, pp. 341–354.

Following the usual procedure in the natural sciences, the geographic and other generalizations made in this paper are all drawn with reference to the dominant mature soils of each group, except where properly qualified references are made to certain young soils of unusual moment.

The Non-Lime-Accumulating Soils

While this division of soils is defined on the basis of a single unqualified characteristic, other broad generalizations may nevertheless be noted. The mature soils are usually light in color—grays, yellows, reds, and light browns. They are commonly low in potash, nitrates, and phosphates. Their structure is not finely granular but coarse, nutty, and cloddy. From the agricultural standpoint, this major division of soils is less fertile than, and inferior to, the lime-accumulating soils. Important differences, nevertheless, exist between the several groups which constitute the larger unit. The more important members include the laterites, *podsols*, *rederths*, *gray-brownerths* and *prairyerths*. Soil literature, in common with other young sciences, is still deficient in acceptable terminology, no suitable phrases or single names existing for many important processes, soil groups, characteristics, etc. The two Russian group names, *podsol* and *chernozem*, are in general use and have been found satisfactory. But the red forest group, the brown forest group (Ramann's Braunerden), the semiarid chestnut-colored group, the gray desert group, and the prairie group are not acceptably designated. These phrases include vegetational, climatic, and color qualifications employed without consistency. The writer accordingly proposes the terms *rederths*, *gray-brownerths*, *chestnuterths*, *grayerths*, and *prairyerths* for the respective divisions, the names corresponding to the Russian chernozem (black earth).[12]

The Laterites

The hot rainy tropics represent one of the world's extreme types of climates. Temperatures are high, and the rainfall is heavy during much of the year. The native vegetation is broad-leaved evergreen forests, and a relatively dense canopy shades the forest floor. The forest litter does not collect as undecayed organic matter, however, but decomposes rapidly.

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[12] The names were submitted for criticism to Dr. Marbut. In the absence of a thoroughly scientific scheme of nomenclature, he deemed them appropriate and acceptable.

The normal soils of these regions—the laterites—are very striking. They are usually red in color and are quite thoroughly leached. Under the influence of heavy rainfall and high temperatures, the mineral matter of the original parent material has been largely broken down. Iron and aluminum are concentrated in the B horizon, but the critical soluble plant foods have been dissolved by internal drainage waters and carried out of the solum. In spite of the heavy forest cover, the organic matter or humus content is slight. The soils are very low in lime and acid in reaction. They are deficient in potash and phosphates. They are "poor" soils. The structure, however, is coarsely granular or nutlike: and the soils are friable, break up readily, and form fairly good, though not ideal, seed beds.

Even in the virgin[13] state, the laterites are not well suited to farming—particularly commercial agriculture. When cleared, the soil is in early, if not immediate, need of fertilization and will not endure continuous cropping without the most careful and persistent attention. Both lime and organic matter are required since the forest mold and the soil structure are subject to rapid disappearance under cultivation.[14] Most of the natives practice only a crude patch or garden agriculture in forest clearings. As the soils are so low in the critical elements of fertility, land abandonment and new clearings—a nomadic agriculture—are consequent characteristics of the native practices. Only the fresh young soils of the flood plains or the constantly rejuvenated soils of the hilly areas are continuously usable without heavy fertilization; but these situations create problems of flood control and soil erosion.

The climatic conditions under which the laterites develop are excellent for plant growth; but these very characteristics make them unfavorable for the development of soils which are naturally good agriculturally. They are also disadvantageously located from the standpoint of health and sanitation. The dual handicap has been generally inimical to the support of even a moderate population. The soils seem capable of supporting a greater number, however, provided the food supply be confined largely to low-latitude produce. At present, population density has attained only a noteworthy figure on young unleached soils of the river valleys or freshly rejuvenated hill or mountain soils.[15] Here moderate to dense populations may find conditions adequate for maintenance. These situations are also utilized for plantation agriculture by foreign capital.

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[13] Only virgin soils, i.e. soils as they exist naturally, are described in this paper. Modifications brought about by man—such as plowing, fertilizing, leveling—destroy or alter the natural characteristics.

[14] C. F. Marbut and C. B. Manifold: The Soils of the Amazon Basin in Relation to Agricultural Possibilities, *Geogr. Rev.*, Vol. 16, 1926, pp. 414–442.

[15] Soils on slope lands are generally less leached than those mantling the smooth uplands due to erosion.

The Podsols

Coniferous forest constitutes the dominant natural vegetation of much of central and northern North America and northern Eurasia. The typical mature soil of this environment is whitish or gray in the surface horizon and has been given the Russian name, *podsol*, the age-old folk term applied to the gray soils of northern Russia.[16]

The climate is wet and cool with long frozen winters and relatively brief summers. The short summers do not promote rapid mineral decomposition, but the mature soils are nevertheless leached and impoverished as the rains of this season readily dissolve the small amount of soluble materials formed. The immediate surface of the virgin soil is dark, owing to the accumulation of raw humus from the fallen vegetable débris, but the underlying horizon is gray or whitish because of the removal by the percolating acid waters of iron oxides. It is structureless and powdery when dry.

The soils are acid and deficient in organic matter. Raw humus lies *on* the surface, but the dense shade of the timber cover and the cool moist climate are not conducive to the existence of the soil organisms that ordinarily assist in its decomposition and bring about its incorporation with the soil. The organic compounds break down eventually, though slowly, but the soluble substances are swept, with small amounts of the other materials leached from the surface, to the zone below the white, grayish A horizon and there precipitated. The solum, in a sense, therefore, is upside down, as the organic matter is "under the soil." This zone in which the organic matter has been deposited is typically brown or coffee-colored. It is sometimes indurated, the hardened zone forming the so-called *Ortstein* of the German literature. The podsols, however, are normal soils which are widely developed and should not be viewed as abnormal or unnatural.

The podsols, like the laterites, are not "strong soils" under cultivation. Manuring or fertilization is necessary for continued successful cropping.[17] The acid conditions call for heavy applications of lime. Phosphatic, nitrogenous, and potassic fertilizers must also be applied. The lack of structure makes the mature soils of heavy texture dense and difficult to manipulate. The soil bakes and forms extremely hard clods if plowed when too wet.

The system of agriculture, especially in the more backward areas, is not far removed from, if not essentially similar to, the patch agriculture of the laterites. Nature's landscape still dominates over the cultural landscape of man, the farmed areas being scattered here and there through the forest. The short growing season is a further limitation; the chief staple crops produced are those suited to both soil and climate, such as rye, barley, and potatoes. In fact, the soils are not far from the present margins of economic production. They are employed largely for subsistence agriculture. Commercial crops are confined to a limited production of specialties, like potatoes (Maine), or dairy products where good access to markets exists (Finland). Many regions having this group of soils are nearly uninhabited, the natives spending much of their time in hunting and fishing.

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[16] The name is derived from the Russian word *sola*, meaning ashes.

[17] See L. A. Hurst and Others: Soil Survey of the Aroostook Area, Maine, *U. S. Dept. of Agric., Field Operations of the Bur. of Soils, 1917* [*19th Rept.*], pp. 7–46; J. O. Veatch and Others: Reconnaissance Soil Survey of Ontonagon County, Michigan, *ibid., 1921* [*23rd Rept.*], pp. 73–100; and others.

The Rederths

The rederths embody the podsolic red forest soils of the middle latitudes. These soils have certain features in common with the lateritic[18] red loams of the tropics, but the subsoils of the latter have a pronounced zone of iron oxide accumulation in which impure bodies of iron are segregated. In this paper the two are described together, owing to their general geographical similarity and the fragmentary data available on the tropic soils.[19]

The normal rainfall under which these soils develop is fairly heavy, and the temperatures average well above freezing; but the mature soils are not as thoroughly leached as the true laterites or podsols. The A horizons, under virgin conditions, are generally yellowish, gray, or faint reddish, although stained in the upper part by organic matter. They are overlain, in forest environments, by thin layers of leaf mold and undecomposed leafy materials. The B horizons, however, are red. Since the thin dark-colored surface is intermingled with the substructure in cultivation or is often eroded away, the fields are reddish in color, and the soils are qualified in accordance with this tinge.

The mature soils have a low but significant content of nitrates, lime, potash, and phosphorus.[20] The structure of the finer-textured rederths is moderately coarse and fairly well developed; that of the red loams about which published information is available is exceptionally well developed, the soils being remarkable for their ready friability and great porosity, even where the types are the finest of clays.

While the growing season of the climates in which these soils occur is interrupted in the tropic areas by a dry and in the middle latitudes by a cool season, the crop adaptation from the climatic standpoint is nevertheless comparatively large. The soils, as a whole, are not highly productive in their natural condition, however. They are not well adapted to important grains like corn or nutritious pasture grasses capable of producing meat of high quality. The low nitrogen content is disadvantageous in cereal culture, and the acidic conditions to calciphilous crops, such as alfalfa and blue grass.

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[18] Podsolic soils are podsol-like soils; they have been subject to the same soil-forming processes which produce podsols. Lateritic soils are laterite-like soils in the same sense.

[19] See, however, Shantz and Marbut, *op. cit.*, pp. 127–128 and 192–208; Bennett and Allison, *op. cit.* The area of distribution of the rederths includes large bodies of soils whose subsoils are yellowish. The yellowerths occupy relatively flat lands and are less perfectly drained but have the same general agricultural relationships.

[20] Not all soils of this group are low in potash: the red Cecil soils of the southern Appalachian Piedmont have a high potash content. See R. C. Jurney and Others: Soil Survey of Guilford Country, North Carolina, *U. S. Dept. of Agric., Field Operations of the Bur. of Soils, 1920* [*22nd Rept.*], pp. 167–199; reference on pp. 176–177. There are also local variations in respect to the other elements named.

The normal red loams about which we have information are unusual in the extent to which they seem capable of prolonged cultivation without apparent noteworthy deterioration. The virgin rederths of middle latitudes have not been amenable to continuous cultivation, however, without early degeneration. Fertilizers are necessary; and seminomadic methods are locally in practice, as the soils decrease rapidly in productiveness. New fields, for example, are frequently brought under cultivation in the North American Cotton Belt. The restricted fertility is an economic imperfection of great geographic significance, as the rederths occupy belts on the borders of the tropics. Here climate is less enervating to man than in the hot, wet tropics, but curtailed productiveness of the soil is a limit to agriculture or burdens it with a heavy cost of fertilizers; and these qualifications react upon population which has reached a high density only under favorable local conditions or at the expense of living standards.

While the virgin rederths as a group are naturally more fertile than either the laterites or the podsols, their use for commercial agriculture has not been proportionate to their greater fertility. The commodities produced for export are chiefly the fruits of fertilized or young and better soil bodies included in the general area. The leading products, moreover, are largely specialties—cotton, tea, peanuts, coffee, bananas, sugar—although there are limited amounts of staple food crops like rice.

The occurrence of a large part of densely populated China in the region of the rederths is of unusual interest in view of the natural low fertility of the group. These peoples make little or no use of their mature upland soils, however, but are crowded along the rivers. The floods are tragic; but the soils are young, fresh, and tillable and are periodically renewed. The natural productiveness is further increased by the extensive use of fertilizers.

The population, outside of the flood plains, is in hill and low-mountain country, whose slopes have been laboriously carved into terraces. Their soils (if we may base judgment on studies made in this country) are also pedologically immature. They were constantly rejuvenated in their natural state by erosion, and if man's use has tended to decrease their fertility it has probably been offset to some degree by the general use of fertilizers. It should also be noted that the soils occur in a region which is a more or less common meeting ground of a good food-producing climate and a fair "man climate," that is with stimulating winters. The combination is a geographic alliance of the first magnitude. There is no reason why the industrious Chinese should not be farmers for forty centuries.

The North American Cotton Belt, with which China is so frequently contrasted agriculturally, is largely a region of mature soils, however, with the noteworthy exceptions of the flood plains of the Mississippi and local areas of hill and limestone country. A high proportion of the soils, moreover, are prevailingly sandy. From the standpoint of productiveness, therefore, the soils as a whole are quite inferior to the young unleached soils of China. The reader is reminded that comparisons or contrasts noted in this paper are *regional*, not local qualifications. Soil regions differ locally as widely as vegetational, major land-form, and other larger groupings.[21]

The fundamental difference in the types of soils used for agriculture in China and the Cotton Belt has not been generally taken into account by the innumerable writers who have enthusiastically pointed to China's agricultural success as a "model" for the North American Gulf States. The American farmer, however, began his "struggle" and is still struggling with soils which were fundamentally poor and will always require fertilizers, while the Chinese had, and apparently still have, young productive and unleached soils.

The Gray-Brownerths

The cool humid lands of northwestern Europe and the northeastern United States, with long growing seasons and relatively short frozen or frosty winters, also develop podsolic soils; but these are light brown to grayish brown in color and are less leached and less acid than any of the soil groups heretofore mentioned. The gray-brownerths are also widely developed in Pacific America, the Mediterranean world, and elsewhere. It should be observed that the exact location of most of the soil groups named in this paper is not known, with the exception of those occurring in Europe and the United States. Little or no detail mapping has been done outside of these continents, although world soil maps based largely on climatic data have been constructed by the Russians, Germans, and others. Effort is being made to present a tentative soil map of the world at the Second International Soil Congress in 1930.

The gray-brownerths are low in lime and only moderate in fertility but have good structures (angular, nutlike granules ranging up to half an inch in size) and react quickly to improvements and fertilizers. They develop under forest covers—chiefly deciduous—the more open canopy, as compared with the coniferous trees of the podsols, permitting the existence of soil fauna. These organisms are instrumental in the decomposition process of the vegetable débris, which falls to the surface in fair profusion. The material does not accumulate as raw humus under normal conditions but is more or less incorporated with surface horizons and, in contrast with the podsols, is not transferred and concentrated in the subsoil. The soils will not submit to continued farming without the addition of nitrogenous matter, however, as the content of organic matter is low and soon becomes "exhausted." They also lose their structure if improperly handled.

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[21] See, for example, J. A. Kerr and Others: Soil Survey of Natchitoches Parish, La., *U. S. Dept. of Agric., Field Operations of the Bur. of Soils, 1921* [*23rd Rept.*], pp. 1395–1441. Here the field party, of which the writer was a member, mapped 24 different soil series and 44 soil types in an area of 1265 square miles.

The gray-brownerths take first rank among the humid forest soils as regards native fertility. Moderately long summers favor a more complete mineral decomposition and the release of more soluble plant food elements than is the case with the podsols. Cold winters are of considerable importance in checking the continuous all-year-round leaching, which characterizes the rederths. Under cultivation there is also less surface erosion during this season than that to which the rederths are subject. The nongrowing but open winter seasons of the latter expose the soils to severe erosion when not protected by cover crops.

The summers of the areas in which the gray-brownerths occur are generally hot; yet weather changes are frequent, and the climatic average is stimulating to man. Since the potash and phosphate, as well as the lime and nitrate content of the soils is not high, the use of fertilizers is general,[22] the forms employed varying with intensity of agriculture and economic conditions. Animal manure forms a greater proportion of this material in Europe than in America. The crop production of both regions is large and varied, as the soils are responsive to good treatment. The labor factor brings about important differences in yields and crop associations, however, since Europe is densely populated.

The principal crops are divided among grains, roots, hay crops, and specialties. A fair surplus is commonly exported, especially from America, grains and animal products supplying the bulk of the surplus goods. The European is less inclined towards commercial agriculture in staple crops than the American. He devotes himself largely to specialties—fruits, dairy products, wine, etc. The American has passed little beyond the extensive stage, however.

The production of the gray-brownerths is especially noteworthy in view of their topography. The land forms include large areas of rough, hilly country, the Appalachians and the highlands of western

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[22] The poor soils of western Europe greatly stimulated experimental work in the use of fertilizers in the nineteenth century. The famous Rothamsted station of England stands among the aristocracy in this respect. For a summary account of the agricultural revolution as affected by the "discovery" of rotation and the rôle of fertilizers see C. F. Marbut: The Rise, Decline, and Revival of Malthusianism in Relation to Geography and Character of Soils, *Annals Assn. of Amer. Geogrs.*, Vol. 15, 1925, pp. 1–25.

Europe for instance. As a whole they are nevertheless noted for their well developed and progressive agriculture, although handicapped by the need of continuous fertilization.

The Lime-Accumulating Soils

The lime-accumulating soils, the second division of the highest soil category, occur in regions of light to intermediate rainfall. The mature soils are fundamentally characterized by their calcium carbonate accumulations, the material forming whitish or grayish zones in the lower B horizons. These zones are popularly called the lime zone. Lime is usually present in some quantity throughout the entire soil mass but is highly concentrated in the lower part of the subsoil where some of it may separate as nodules, flecks, and concretions. The accumulation occurs, moreover, regardless of the character of the parent material. It is a typical soil evolution phenomenon and is not a product of geological processes except in the broader, more inclusive sense of the science.

The soils of this division vary widely in color—from the light-colored members of the desert to the black series of the well grassed plains—the colors ranging with climate and vegetative covering. From the chemical standpoint, they are relatively unleached. The soils have experienced marked changes, however, and are quite unlike their parent materials, as both physical and chemical alterations have occurred. The most striking chemical change has been indicated—the transfer and accumulation of lime in the B horizon. The important physical changes include the structural organization. There is no noteworthy tendency, however, for the B horizon to develop pronounced heavier-textured horizons than the surface zones. This latter feature seems to be normally characteristic of only mature non-lime-accumulating soils.

The soils as a class are adequately supplied with "plant foods" and rank as good fertile agricultural soils, although their production may be markedly limited by the low rainfall of their area of distribution. Three outstanding groups may be recognized—the grayerths of the deserts, the chestnuterths of the semiarid regions, and the chernozems of the transitional, subhumid rainfall belts. Significant differences include not only color but also structure, the depth of the lime zone, and other characteristics.

The Chestnuterths

The chestnuterths include the intermediate colored group, the browns[23] to chestnut browns. These soils have developed under the semiarid conditions of both middle and low latitudes. The typical vegetation is grass, the plant associations being of varied character. There is a fair to good percentage of nitrogen as the fine roots are intimately commingled with the soil mass. In view of the light rainfall the soils are unleached. They have a good percentage of all constituents necessary for high productivity.

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[23] The brownerths lie between the chestnuterths and the grayerths of the desert, but space precludes their description here. Their geographic relationships include both chestnuterth and grayerth features.

The chestnuterths are also marked by roughly developed granulation, the soil material being organized into small clodlike structures. The upper surface horizon may be only a loose structureless dust mulch, but the understructure is coarse and cloddy. The soil is very amenable to plowing, however, the smooth and level plains, upon which it is typically developed, being ideal for machine culture.

While the climate under which these soils have developed is semiarid, the average rainfall is heavy enough to produce a natural growth suitable for grazing. Agriculture is practiced with the assistance of specialized farming methods, such as dry farming, and drought-resistant crops, like sorghum and kaffir are produced; but the dominant activity is necessarily the pastoral one. The live stock varies with latitude, pasture conditions, and other factors—sheep, cattle, goats, camels, etc. being grazed. The native vegetation, made up largely of grassland formations, furnishes good pasturage in the middle latitudes, but it is often coarse and only fair in the great grasslands of the tropics. The quality of the meat produced in the latter areas is low in grade, as even good stock is incapable of producing high-quality beef on inferior forage. Nomadism is common, and outside of the thickly settled oases the population density is low, the ratio of man to land acreage in some cases being very small. The river oases are chiefly "islands" of fresh "foreign" soil and greater water supply which have invaded the region along drainage lines.

THE GRAYERTHS

The surfaces of desert regions are characteristically pebbly, sandy, or rocky. The pebbly areas exhibit the typical soils of the desert. The loose, shifting sand of the dunes does not constitute soil in the scientific sense. The stone deserts are completely destitute of even unconsolidated soil-forming materials except such coarse débris as is not removed by the wind.

The pebbles are highly polished and form the well known desert pavement. This horizon is thin, usually not more than an inch or two in thickness, and light in color—gray or very light brown. The underlying zones are variable. They are whitish or brownish, loose, and seemingly structureless. The soils, however, have lime zones, similar in nature and origin to those of the chestnuterths; but the position in the solum is close to the surface. The low rainfall has reduced the internal translocation processes to the minimum.

The natural vegetation is scattered, harsh, and scanty; and the animal world which depends upon it is proportionately reduced in numbers. The great bulk of the desert is empty except for the scattered pastoral nomads with flocks of sheep, goats, and camels. The animals crop the scrubby tough herbage, giving meat of low quality. Dense populations of considerable size are associated only with the fresher irrigated soils of the piedmont plains (Salt Lake Oasis) or streams, such as the Nile, which arise outside of the desert and bring water as well as younger soils to the dry wastes of sand, stone, and pebbles.

THE CHERNOZEMS

Belts of relatively intermediate climate separate the semiarid from the humid lands in both the middle and low latitudes. The natural vegetation is tall grass, which grades into short-grassed steppes on the drier margins. The soils are well known for their dark coloration—the black earths—dark brown to black in the cooler middle latitudes, with lighter colors prevailing in the tropics. In common with other soils developed under low rainfall conditions, they are both nonacid and have lime accumulating in a distinct zone in the subsoil (Fig. 3). The phosphorus and potash content is medium to high. They have excellent structure, the perfection as a group being unsurpassed. The structure particles are small in constitution—not coarse and cloddy like the chestnuterths. The chernozems include soils in the middle latitudes, moreover, with such excellent granulation that they are unequaled for ease of cultivation and plow agriculture, the soil being capable of forming a perfect tilth. Such soils occur in central Nebraska and Kansas. They may be said to "melt in one's mouth" as far as their natural cleavage is concerned.

The soils are highly fertile and show no indication of natural impoverishment. The internal drainage is excellent, but the normal soils have not experienced a marked translocation of the finer materials, such as clay, from the A to the B horizons. The latter may be slightly more compact than the upper zones, but the differences which mark the humid soils (relatively light-textured surface soils and heavy-textured subsoils) are not in evidence. In fact, chernozems constitute the ideal group from the "good soil" standpoint.

When rainfall is adequate these soils are capable of exceeding all others, with the exception of certain young black limestone and fresh, "alluvial" soils, in both crop production and ability to maintain a continuous cropping system when properly tilled and managed. The chief limiting factor is obviously precipitation, as the rainfall is low to moderate. In this sense they stand opposite the laterites. The chernozems are the "best soils" but have a poor agricultural climate; the laterites have the "best climate" as far as abundance of rainfall and high temperatures are concerned, but they are leached and impoverished.

The dark chernozems occur in Eurasia, North America, the Argentine, and presumably Australia; the lighter-colored members in the hotter climates of the tropics and extra tropics. The tropical chernozems seem to rank agriculturally below those of the cooler climates, however, as they become soft and sticky when wet, and cracked when dry.[24]

The chernozems, like the red soils of the tropics, constitute one of the more striking soil groups of the world. Their unusual character and large development in Russia was a prime factor in prompting, during the nineteenth century, the investigations of the Russian soil scientists whose stimulating work brought about the development of modern soil science.[25] The agricultural excellence of the black earths is universally axiomatic. They embrace the great grain lands of the middle latitudes, great acreages of which are devoted to breadstuffs, especially wheat. The high nitrogen content and the excellent structure of the soil are especially well suited to the penetrating roots of the cereal crops. Population is not dense, however, since the painstaking garden agriculture of populous Eurasia has been supplanted by the use of machinery. It is probable that the soils are unexcelled in the great surplus which they contribute to international commerce.

The Prairyerths

Between the grayish brown forest soils of the northeastern United States and the chernozems of the low-rainfall belt west of the Missouri River lies a large triangular area whose natural vegetation was the long-grass prairie. It is caught between two prongs of the gray-brownerths, one of which extends northwestward into Minnesota while the other projects southwestward into the Ozarks. All known natural causes seem to indicate that this area, too, should be forest; but for some unknown or incompletely demonstrated reason it is grassland.

The environmental conditions of this area do not seem to be significantly unlike those of the gray-brownerths region, but the soils are very different from those which the environment would lead one to expect. They are very dark brown to black in color and are somewhat acid in reaction, while the humid forest soils are brown in color and very acid in reaction. The soils, at least as regards their more important characteristics, show closer resemblance to the chernozems. The coloration is similar, the profuse roots of the long prairie grasses having been thoroughly commingled with the upper soil mass in the process of soil evolution. The soil material, moreover, is friable and easily worked, as the structure is finely granular, not nutlike as in the forest. The subsoil is often compacted, but it is usually not markedly heavier-textured than the surface horizons. The chief exception, in addition to acid reaction, is the lack of a zone of lime accumulation at maturity. The prairyerths, therefore, belong to the non-lime-accumulating group, although they have important features in common with the lime-accumulating soils. Certain immature soils of the region (northern Iowa) are still possessed of lime inherited from geological processes, but this lime is being gradually lost through the drainage waters and is not accumulating in the lower subsoil. It does not appear, however, that the mature soils are as acid or as low as the forest soils in either potash or phosphates, but they are benefited by the application of lime and manure in moderate quantities.

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[24] Shantz and Marbut, *op. cit.*, pp. 165–166.

[25] For detailed descriptions of several soil series of the American chernozems, or black earths, see the Soil Survey Report of Adams County, Nebraska, by F. A. Hayes, the authority on the central black earths of the United States, or the writer's report on Nuckolls County (both in publication).

These soils, like the chernozems, are developed chiefly on smooth-plains topography. The rainfall, however, is from 50 to 100 per cent higher, and the crop production is heavy and usually certain. Their area of distribution is roughly coincident with the western two-thirds of the Corn Belt. Smaller bodies exist farther west; and similar soils are believed to occur elsewhere, but their existence is not yet fully verified. With only a moderate population density, the known prairyerths have had an enormous surplus and have poured vast quantities of meat and grain on the international markets in addition to feeding a large part of the population of the United States. These dark-colored soils and the black chernozems together probably contribute more foodstuffs to world commerce than any other equal area of soils. They are extremely productive. From the standpoint of agricultural economics it is unfortunate that the chernozems and prairyerths have not a larger area of distribution. They are the prize soils of the world.

A MAP OF THE WORLD'S LAW

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[With separate map, Pl. II, facing p. 120]

A MAP of the world's law! Has any one ever seen such a map? There have been world maps of rainfall and of temperature, of cereal crops and of timber belts, of population and of illiteracy, of race stocks and of religious creeds, and of all the fundamental geologic, zoölogic, economic, and social facts. But of law? We do not know of any map that has hitherto seen the light in print.

But, a map of the world's *laws?* There would be millions of laws; no map could record them. Nevertheless, all these laws fall into *systems* of law, and these systems of law are limited in number and can be mapped. Every nation, every locality, every tribe, throughout the earth's surface has of course had its customary laws, since the beginning of social history. But in only a few instances have these local customs developed into systems. A system of law is a body of rules covering the elemental institutions of social life, developed by the thought of a professional class, and connected into a sort of corporeal unity by a certain logical and social consistency. These systems, when once formed, have held together for centuries and have often spread from their native area to include widely unrelated peoples. Today, more than nine-tenths of the world's population live under the influence, direct or indirect, of less than a dozen systems of law.

Originally, some sixteen systems can be traced in the world's history; they are sketched in my book "A Panorama of the World's Legal Systems."[1] But of these sixteen some eight have disappeared as such—the Egyptian, Mesopotamian, Hebrew, Greek, Roman, Celtic, Maritime, and Canon systems. There remain, represented on the world's surface today, either pure or in combination, the following: Chinese, Hindu, Japanese, Germanic, Slavic, Mohammedan, Romanesque, Anglican. Besides, there must be added, for notation on a map, Tribal Custom, for areas where no system had developed.

GEOGRAPHY AND THE LAW

But before explaining the map, a few words should be said as to the influence of geography in the evolution of law in the earth's peoples.

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[1] John H. Wigmore: A Panorama of the World's Legal Systems, 3 vols., St. Paul, Minn., 1928.

Nothing comprehensive yet has been attempted on this subject,[2] and at this time only a few suggestions of its possibilities will be made.

The influence of geography has operated in two ways—immediately, through natural features, and mediately, through race and race traits. The latter form—mediately, through race—has been vital. All except three of the principal legal systems have originated in particular race stocks and have usually taken on their distinctive traits before the race stock had been diluted or the system transplanted. The three exceptions—Maritime, Papal, and Romanesque law—have arisen independently of race. The first had a geographical origin, the second a religious, and the third an intellectual. But the study of this indirect race influence would lead us too far afield.

Direct geographical influence is of course bound to be elusive: it is seldom easy to disentangle it, as a cause, from the other numerous circumstances attending the growth of a legal system. One or two instances must here suffice.

Terrestrial distribution, that is land versus water, led to the growth of a maritime legal system distinct from any racial or national territorial systems. But coast line seems, oddly enough, to have had little direct influence; for the Romans of Italy, with an extensive coast line, were weak in maritime law, borrowing theirs from the island of Rhodes; and the English similarly borrowed theirs from France.

Contiguity has had much to do with the growth of some legal systems, by producing imitation or peaceful penetration among neighboring peoples. For example, the Mesopotamian system (of Babylonia and Assyria) seems to have been assimilated in adjacent regions; the early native Egyptian system spread westward; and the Germanic system penetrated the adjacent Slavic regions.

Mohammedan law is in its origin a law of the desert. The close relation between the region of Mohammedan law and the great continuous area of scant rainfall (below 10 inches) and of interior-basin drainage in the Old World is striking.[3] At the same time within the system there are interesting differences for the desert proper and the oases: as between Bedouin Law and the Egyptian Penal Code.[4] On the other hand, climate seems to have had no influence on the Buddhist religious legal system, which, originating in the warm plains of India, spread northwards into the icy plateau of Tibet and the dreary steppes of Mongolia.

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[2] In Kocourek and Wigmore's Evolution of Law Series (1917), a compilation from the world's legal literature, Vol. 3, "Factors of Legal Evolution," contains two suggestive chapters, viz. Mr. H. J. Randall's "Law and Geography," and Miss Ellen Semple's "Influences of Geographic Environment on Law, State, and Society." Of concrete treatment an example will be found in Mr. Henry A. Dubbs's "The Unfolding of Law in the Mountain Region," *Colorado Mag.*, Vol. 3, 1926, pp. 113–132.

[3] See Pl. I, B and C, in Isaiah Bowman: The Mohammedan World, *Geogr. Rev.*, Vol. 14, 1924, pp. 62–74.

[4] See, for instance, Austin Kennett: Bedouin Justice: Laws and Customs Among the Egyptian Bedouin, Cambridge, 1925.

The above instances refer to systems as a whole: when we come to particular rules of law within a system, causative influences are more readily detected. In the *form* of law, the records embodying it vary directly with the materials available in a particular region: the Egyptian papyrus, the Babylonian baked clay tablets, early Arabian records on camel bones are obvious examples. The *place* of doing justice is often suggestive. Among the Mohammedan peoples justice was dispensed at the door of the tent, at the shady gate of the city or the temple, or within the mosque. So too with modes of punishment. In India execution by the trampling of a trained elephant was observed as late as 1880. In Central Africa the guilty person might be bound to an ant hill, to be devoured to the bone.

The incidents of landownership—the various petty dues, fees, and rights—naturally varied with the environment. In India landownership carried the right of fastening elephants and buffaloes for pasture; in England the owner was entitled to "wood bote," a service of wood cutting; in Mesopotamia and Egypt the irrigation customs were vital, as indeed irrigation customs are in arid lands the world over, today as in the past. Thus the extant deeds of land from the various systems contain clauses characteristic of the variant regions.

So, too, bodies of rules of law will be found in one system which do not appear at all in systems located among other natural features; for example, rules for dikes in Holland, for canals in Spanish Granada, where a "water court" exists even now, for mountain pasture in Switzerland and Norway, for cattle in Ireland.

In family law certain rules were widely different, and the differing social conditions producing them had no doubt some geographical basis. The detailed causes here would be very difficult to disentangle. One of the largest questions would be how far polygamy, as a regular order of life, was influenced by tropical conditions. Another question would be how far geographical conditions controlled the rules of inheritance. As to this, it is certain the English rule of male primogeniture for land, which drove away the vigorous younger sons to seek their fortune elsewhere, was later a prime cause in the growth of England's colonial empire, and thus of the world-wide spread of the Anglican legal system. But whether that rule itself—the rule of male primogeniture—was due to the unconscious influence of England's narrow island limits, inculcating the indivisibility of estates, and thus to geographical facts, is a conundrum; and only a careful analysis of comparative history and other facts would reveal the answer.

When we come to specific rules of commercial law, it becomes even harder to detect a geographical influence. For example, the much mooted question whether in a sale of goods the title to the goods passes to the vendee by the mere agreement to sell or not until manual delivery of the goods—if we find that the one version was adopted among the Germanics of Europe and the other was adopted among the Mohammedans of the north African deserts and mountains, are we to look for some climatic or other geographical fact as the explanatory one?

The foregoing instances will at least suggest not only the rich possibilities of the subject but also the complexity of the task of tracing the influence of geography upon law.

THE MAP: CLASSIFICATION OF SYSTEMS

On the map, Plate II, systems alone can be separately shown, i. e. the few developed bodies of law, not the innumerable unorganized groups of tribal custom. But all systems now in existence are more or less mixed in origin and history, and the various shades of these mixtures are too numerous to be represented. Hence only the system representing the present dominant character or characters of the law in a given nation or area can be shown.

Nevertheless, some mixtures cannot be ignored. In certain areas, to show a single unmixed system would be misleading and would be valueless for the purpose of analyzing tendencies. Therefore at least four distinctions in types of mixtures seem necessary as well as feasible to represent on the map. These four types are as follows:

1. *Pure* systems, that is as in England or France.
2. *National blends*, that is where a people having a native system has adopted in part an alien system by recasting its native system in alien categories or otherwise, thus making a single blended system under native sovereignty, as in Japan.
3. *Colonial composites*, that is where an alien power, holding a colony or protectorate or mandate, has imposed its own political or public law but continues to preserve and enforce the native system for private law, in part or in whole, as in Algeria.
4. *Colonial duplex composites*, that is where an alien power has imposed its own system but enforces two or more native systems for separate classes of natives. India is the only notable example of this type.

Extraterritoriality is not here shown, that is where a native sovereignty enforces foreign law for the alien residents as a separate class of persons, either in consular courts or in mixed courts; this form of jurisdiction does not add to the types of systems, though it may affect large numbers of the population.

On the above four types further comments must be made:

Pure systems. Of the sixteen systems mentioned above only eight can be recognized to be surviving as such in today's world, viz. Anglican, Chinese, Germanic, Hindu, Japanese, Mohammedan, Romanesque, Slavic.

Of these eight only four are now found anywhere as pure systems, viz. Anglican, Hindu, Mohammedan, Romanesque; the others appear only in blends or composites.

Blends. The distinction between a blend and a composite is this: in a blend various institutions from two systems are fused into a single system under native sovereignty, applicable to all persons in the jurisdiction (except extraterritorial exemptions); but in a composite the two systems remain separate, each being applicable to a different group of persons. Thus there might conceivably be a *national* composite: there is, in fact, in Egypt and elsewhere, and there was in imperial Russia, a national composite, though for groups of persons too small to be here recognized. But on this map the blends are only national, that is under native sovereignty; and the composites are only colonial, that is under alien sovereignty.

One particular blend calls for special note, viz. the Russian Soviet Federation. Here the foundation is still more or less the historical Romanized Slavic blend, nominally displaced by the Communist system; but the Communist institutions are formulated in Romanesque categories, and at the present time it seems best to class the system as a blend, not a new independent system.

Blends, of course, differ in the degree of actual application of the borrowed system as law. For example, in Japan and Siam the blend has long been thorough; in China it has made substantial start; in Turkey it is as yet beginning; in Persia it is in embryo. No attempt to show such differences is made on this map. Nor can the map attempt to show differences in the various parts chosen from the two systems for blending. For example, in Scotland and in the South African Republic the elements taken from the Romanesque system would be very different from the Romanesque elements taken by Japan, by China, by Persia, by Siam.

Blends are of course open to difference of opinion in respect to the *quantity* of a blended element that entitles it to recognition for particular nations. For example, Scotland and the South African Republic are commonly classed under the Romanesque system; yet the Anglican element is too large to be ignored, and therefore both those countries are shown on the map as blends. The Scandinavian countries are also commonly classed as Romanesque; yet the Germanic system (obsolete everywhere in its pure form) is there so largely preserved that it cannot justly be ignored, and all of those countries are therefore shown as blends. For these and other countries the map has chosen solutions which are no doubt open to difference of opinion.

Composites. In a composite system the number of native systems (that is, of "personal" law) that might be actually enforced by an alien sovereignty is of course theoretically large. In some countries, no doubt, it is at least plural. But only the one major native system is recognized on this map; that is, the one in force among the large mass of the population. The only composite country for which two native systems are shown on the map is India, where Hindu law and Mohammedan law must each be recognized.

Where no organized system is found, but only *local tribal customs*, this infinitely variegated type is represented on the map by a single symbol. It always appears as a composite, of course, because the whole terrestrial surface is now nominally under the sovereignty of one or another national power; and thus the areas in which local tribal custom still obtains are usually under one or another alien power, either as colonies, protectorates, or mandates. Local tribal custom is of course recognized, or actually in force, in many areas of Asia and of Africa too small to be designated on the map. Some of them, moreover, are in strictness national composites, not colonial composites.

In the lesser known or more recently dominated areas of Africa and Asia, there are many border regions where the allotment of systems must of course be tentative only. For example, in Africa the region of Mohammedan law (as a composite element) shades off gradually into the region of tribal custom. So, too, in northwestern and north-central Asia, the areas of tribal custom, as contrasted with the surrounding Chinese, Hindu, Mohammedan, and Soviet systems, leave many doubtful border lines. The map here attempts to show no more than broad tendencies.

As to the kind of law—public law, etc.—that is imposed by the alien political power in colonial composite systems, this differs, of course, under different powers. Alien taxation law and police law are always found; also more or less penal law and often judiciary organization. Civil procedure is sometimes included, as in India; sometimes not, as in Morocco. No attempt is made to represent these variations on the map.

SYMBOLS USED ON THE MAP

The representation of these types of systems on a map can best be made by using colors to indicate the systems, and numerals to identify the regions where the systems obtain.

The four *types* of systems—pure, blend, composite, and duplex composite—are thus distinguished:

1. Pure system = single color, e. g. England, in red (Anglican).
2. Blend = the ground color of the basic system crossed by a bar in color of the blended system, e. g. Turkish Republic, in dark green (Mohammedan) crossed by a bar in blue (Romanesque).
3. Composite = the ground color of the native system sur-

rounded by a marginal boundary in color of the alien system, e. g. Algeria and adjacent French dependencies in dark green (Mohammedan) surrounded by a boundary in blue (Romanesque).

4. Duplex composite = same as in the preceding, but with two ground colors in alternate blocks, e. g. India, in blocks of the Mohammedan and Hindu colors.

Regions—nations, colonies, protectorates, etc.—are indicated by numerical figures. The terrestrial surface is divided into five major divisions, America, Europe, Africa, Asia, Australasia and Oceania. Within each division the several countries, etc., after being arranged alphabetically, are numbered serially, and this number is placed also on the map at the proper location. Countries and possessions not large enough for map marks, or not important enough for distinction from adjacent areas, have been ignored; thus for instance Andorra, whose legal system is *sui generis*. A key below the map lists the region by numbers, and the systems of law by initial letters.

Ascription of Systems to Particular Regions

There is of course some room for difference of opinion in the ascription of systems to particular regions, even of those systems that have long been well known. For regions not yet fully described in authentic legal chronicles, there is even more room for controversy by those who have special knowledge of particular areas. The allotment shown on the map represents the author's opinion—tentative in many instances—formed in the light of available information.

CHANGES IN THE OCEANIC CIRCULATION AND THEIR CLIMATIC CONSEQUENCES

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IN the last decade of the nineteenth century, between 1892 and 1897, there occurred an enormous outburst of ice from the Antarctic which filled the Southern Ocean with ice floes and icebergs to such an extent that traffic between South America, Africa, and Australia had to seek a more northerly track. This outburst had far-reaching climatic repercussions. The monsoon regimen of the Indian Ocean was profoundly disturbed. In India 1893 and 1894 were years of excessive rainfall; then, in 1896 and 1899, came years of drought followed by widespread famine. The area in which crops failed more or less completely was about 256,000 square miles in extent in 1896 and 500,000 square miles in 1899. In 1899–1900 upwards of 6,500,000 people were on famine relief for several months. The loss of cattle was great, running into many millions: in some districts 90 to 95 per cent of the stock died. Australia also suffered. In New South Wales and Queensland almost continuous drought prevailed from 1896 to 1902. It is estimated that over 50,000,000 sheep, valued at £12,500,000, were lost during these seven years.[1]

Reports of ice dangerous to navigation in the Southern Ocean began to appear again in 1922. We do not know which part of the Antarctic shelf was the original seat of this outburst, but it seems likely that it came from the Pacific and Atlantic rather than from the Indian side since its aftereffect has been a disturbance of the Humboldt and the Benguella currents. On the former current Mr. R. C. Murphy has published an elaborate and comprehensive study.[2] He shows that the Humboldt Current must have been deflected westwards early in 1925, allowing the warm coastal waters from the Bay of Panama, i.e. the countercurrent El Niño, to penetrate southwards along the coast and thus cause an abnormal rainfall along the arid coasts of Ecuador, Peru, and Chile. This phenomenon though rare is not unprecedented; it appears to repeat itself periodically at intervals of about 34 years, which reminds one of the Brückner cycle.

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[1] Sir John Eliot: A Preliminary Investigation of the More Important Features of the Meteorology of Southern Asia, the Indian Ocean and Neighboring Countries During the Period 1892–1902, *Indian Meteorol. Memoirs*, Vol. 15, Part I, 1903, pp. 185–307.

[2] R. C. Murphy: Oceanic and Climatic Phenomena Along the West Coast of South America During 1925, *Geogr. Rev.*, Vol. 16, 1926, pp. 26–54.

Simultaneously with the westward deviation of the Humboldt Current there took place a corresponding deviation of the Benguella Current, permitting the warm waters of the Guinea Current to expand southward with a similar effect on the climate of the African sub-continent—torrential rains and inundations. From the British Meteorological Office I have received records of the extraordinary rainfall in Nyasaland and Rhodesia.[3] In the former, the rainfall for the early months of 1925 was the greatest ever experienced within European knowledge of this part of the tropics, and it resulted in excessive damage to crops and communications both here and in Rhodesia and also in parts of South Africa. At Zomba 367 millimeters of rain fell in March, whereas the average is 224 millimeters. In Salisbury the rainfall was 304 millimeters against an average of 214 millimeters. The rainfall of 1926 in Zomba was a repetition of that in 1925 or even worse, being about three times the normal fall. At Mossamedes (lat. 15° 11′), which is perhaps the most arid station on the coast of the African sub-continent, the rainfall in February, 1925, was more than double the highest record ever obtained in that month. Heavy rains are also reported for Namaqualand[4] and Ngamiland.[5]

Outbursts of polar ice also occur in the Arctic. The outburst of 1903 is still fresh in the memory of the Scandinavian countries because it was followed by a general failure of cod, herring, and other fish along the coast from Finmarken and Lofoten to the Skagerrak and Kattegat. The greater part of the Barents Sea was covered with pack ice up to May, the ice border approaching closer to the Murman and Finmarken coasts than ever before. Herds of arctic seals visited these coasts, and some species of the arctic whitefish extended their migrations to the Christiania Fiord and even entered into the Baltic.

A closer inspection of the changes in oceanic circulation with the attendant climatic changes, of which the above are recent examples, suggests a periodicity underlying all these seemingly irregular phenomena. Upon this problem I have been engaged for many years. The first aspect of it to be considered is the process of ice melting and its relation to the general circulation of the ocean waters.

The Ice-Melting Process and Its Dynamics

I began to study this subject 45 years ago when working up the hydrographic observations of Nordenskiöld's *Vega* Expedition on which he accomplished the first circumnavigation of Eurasia (1876–1878). I observed then that in every deep sounding made by Nordenskiöld in the ice-filled Kara Sea and the Arctic Ocean there was always found warm water—water, that is, of a temperature above 0° C.—under the ice wherever the depth was great enough to allow an undercurrent to enter. It was evident that this warm and salt water must have been brought to these remote eastern parts of the North Atlantic by some ramification of the great artery of warm water of that ocean usually called the "Gulf Stream," which thus must exist as an undercurrent long after it has left the surface. For physical reasons I concluded that ice that melts in salt water attracts to the place warm water from the neighborhood. But I could not be sure that this was the only force acting, as the presence of the warm water under the ice floes of the Siberian Sea could also be explained in another manner, viz.: by the deviating influence of the earth's rotation which compels currents from the south to take an easterly direction in the northern hemisphere.

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[3] By courtesy of its Director and staff (Dr. C. E. P. Brooks and Dr. J. Glasspoole).

[4] "The Brak River, during the heavy rains of July 1925, carried water to the Orange River for the first time within the memory of the Hottentots" (W. A. Humphreys: The Changed Conditions of Namaqualand, *Trans. Royal Soc. of South Africa*, Vol. 16, 1927, pp. 219–224).

[5] Bechuanaland Protectorate, *Ann. Colonial Rept.* for 1926–27, London, 1928.

Nordenskiöld's next expedition brought results that settled the question. This time (1883) he went westward to Greenland in search of the site of the old settlements of Norsemen in the Viking age. When his ship crossed the Polar Current to the east coast of Greenland, which had been inaccessible since the beginning of the fifteenth century on account of the polar ice drift, and reached the Gunbjörskjär of the Sagas (Angmagssalik) in latitude 67° the hydrographer, Axel Hamberg, had an opportunity to make a complete series of deep soundings across the Polar Current. The result was as follows:

On the continental shelf off Greenland the Polar Current carried ice and ice-cold water from the surface to the bottom at 150–200 meters, but just outside the shelf there was found an intermediate layer of warm and salt water between the Polar Current and the undermost water layer which was cooled to the freezing point of ice in sea water ($-1°$ to $-1.9°$ C.). This intermediate layer was interpreted as an indraft from the eastern side of the Atlantic which, in spite of the deviating influence of the earth's rotation, had been deflected westward by a stronger and hitherto unknown force which must be an effect of the ice-melting process.

These observations, made 45 years ago and confirmed by a number of similar experiences of recent date in the Arctic and Antarctic seas, bear out the general rule that, without exceptions, *There exists in every ice-filled region of the ocean an indraft of warmer and salter water as an undercurrent from lower latitudes.*[6]

I have demonstrated the process of ice melting and the currents to which it gives rise in the laboratory. My first attempt to solve this problem from the dynamic point of view was published in *Petermanns Mitteilungen.*[7] The operation of the process in the northern Atlantic may be briefly summarized.

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[6] Provided that the depth of the sea is sufficient to permit an undercurrent to enter under the ice and ice-cold surface water.

The northern part of the Atlantic, i.e. the Norwegian Sea and the Polar Basin, is separated from the main part of the ocean by a submarine ridge, extending between Greenland, Iceland, the Faeroes, and Shetland, which impedes the southward movement of the polar ice and divides the Polar Current into two branches. There is a great accumulation of ice in spring north of Denmark Sound between Greenland, Iceland, and Jan Mayen. During the summer this is considerably reduced (see Fig. 1). A part has drifted away with the Polar Current southwards through Denmark Strait. Another part has melted under the influence of the wind and the season. A third part has been melted by the warm undercurrent, a branch of the Gulf Stream which enters the Norwegian Sea over the submarine ridge. The diluted water from the melting ice flows as a surface current, the so-called East Iceland Polar Current, in a southeasterly direction between Iceland and Jan Mayen. The warm Atlantic water which has given up the heat necessary for the melting of the ice sinks down. It has become a little less salt from its contact with the ice, but it is nevertheless denser than before on account of its reduced temperature. It fills the deep basin of the Norwegian Sea to the level of the ridge, over the lowest parts of which, e.g. the Wyville Thomson Bank between the Shetlands and the Faeroes, it escapes as a submarine waterfall into the deep basin of the eastern Atlantic. The large scale on which the melting process goes on in the Norwegian Sea accounts for the fact that this sea contains the coldest (down to −1.93° C.) and densest (up to 1.028) sea water on the globe.

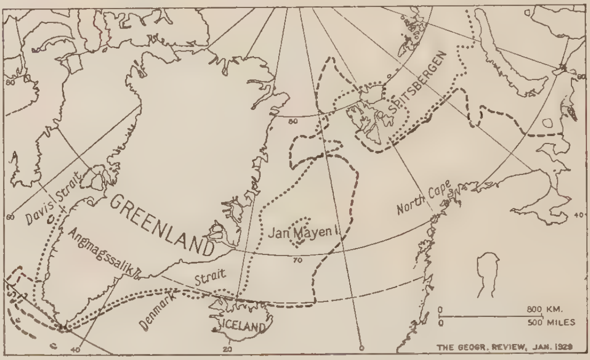

FIG. 1—The state of the ice in the seas east of Greenland and Spitsbergen and in Davis Strait, 1896. The dashed line shows limits of the ice pack in May; the dotted line, limits in July. (Based on charts of the Yearbook of the Danish Meteorological Institute for 1896.)

From the deep soundings of the Danish *Ingolf* Expedition in the year 1896 we infer that there exist in this part of the sea three different water layers. The uppermost belongs to the Polar Current and carries ice-cold diluted sea water of a mean density of 1.0265. It consists of a mixture of $\frac{1}{18}$ ice water of $-1.6°$ C. with a density of 1.00017 and $\frac{17}{18}$ Atlantic water. The second layer consists of Atlantic water with a temperature above zero and 35.06 per mille salinity. Under this warm and salt Atlantic water was found the ice-cold bottom water of the Norwegian Sea of $-0.8°$ or $-0.9°$ C., which consists of Atlantic water that has been cooled by contact with the ice and a little diluted so that its salinity has been reduced to about 34.9 per mille—the characteristic salinity of Arctic water.

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[7] Otto Pettersson: Die Wasserzirkulation im Nordatlantischen Ozean, *Petermanns Mitt.*, Vol. 46, 1900, pp. 61–65 and 81–92. See also *idem:* On the Influence of Ice-Melting upon Oceanic Circulation, *Geogr. Journ.*, Vol. 24, 1904, pp. 285–333, and Vol. 30, 1907, pp. 273–303.

The *Ingolf* soundings also supply data for an estimation of the magnitude of the energy set free by the ice-melting process in nature. From elementary thermodynamic principles I calculated the energy thus developed in summer between Iceland and Jan Mayen at some 388,000 horse power. This is the energy that drives the East Iceland Polar Current, which cannot be considered as a wind current since it flows in a contrary direction to the prevailing winds.

Centers of Action

Mathematically it can be shown that the ice-melting process is of such considerable importance that we must ascribe the vertical circulation in the ocean mainly to this cause. The regions where ice melting on a grand scale goes on may be regarded as real centers of action—this expression, introduced by Teisserenc de Bort in his famous treatises on the dynamics of the atmosphere, being used to denote correspondingly the seats of origin of the current system in the ocean.

Two such centers of paramount interest are situated in the northern hemisphere: in the Norwegian Sea and off the Newfoundland Banks where the ice drift from the Polar Basin and Baffin Bay encounters the warm waters of the united Florida and Antilles currents. In the southern hemisphere also we have two centers: first, the limit of the drift of Antarctic ice floes between latitudes 40° and 50° S.; and, secondly, the border of the Antarctic ice barrier in latitude 70° to 80° where the icebergs of the southern ocean originate.

Our knowledge of the centers of action is due to recent German investigations of which a representation is given in the following section of the Atlantic Ocean along the 30th meridian W., designed by the leaders of the *Meteor* expedition, Merz and Wüst.[8]

The salient features of this section are:

1. The undercurrent of warm and salt water which in depths between 1200 and 3500 meters penetrates the South Atlantic Ocean

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[8] Die Deutsche Atlantische Expedition auf dem Vermessungs- und Forschungsschiff "Meteor," *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1926, pp. 1–77 and 209–274.

from the Sargasso Sea to the Antarctic continental shelf and by contact with the Antarctic ice barrier and ice floes maintains a circulation of the bottom water in the Atlantic Ocean.

2. The undercurrent of cold water from the border of the Antarctic ice drift in latitude 40°–50° S. to about latitude 10° N. at a depth of 400 to 1000 meters.

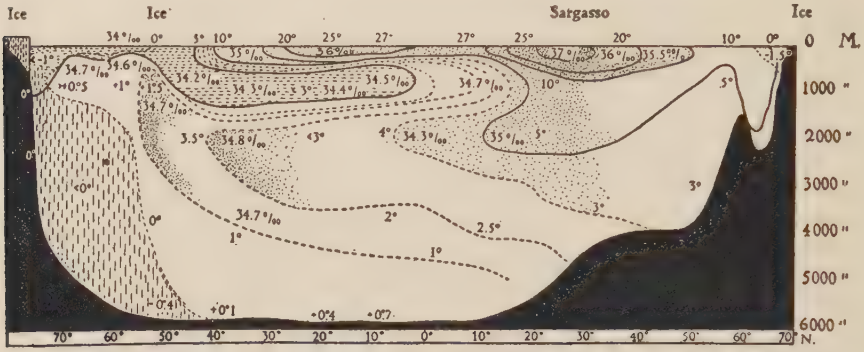

FIG. 2—Longitudinal section of the Atlantic Ocean through longitude 30° W. (After Merz and Wüst.)

THERMODYNAMICS OF THE OCEANIC AND ATMOSPHERIC CIRCULATION

The explanation of the causes of oceanic circulation given above is new and has not been generally adopted by hydrographers, who adhere to the theory propounded fifty years ago by the German physicist Zöppritz that oceanic circulation is caused by the winds.[9] The *vis motrix* of the current system of the sea thus would be a secondary effect borrowed from the atmospheric circulation. It is easy to understand how this theory should become accepted, since experience shows that the great surface currents evidently coincide with and are ruled in their direction (to a certain extent and a certain depth) by the prevailing wind system of the atmosphere (the trade winds, monsoons, etc.). But as an explanation of the oceanic circulation as a whole it is utterly insufficient.

If we abandon the theory of Zöppritz, long and resolutely defended by Krümmel and other authorities, and consider the movements in the sea as mainly caused by direct transformation of radiant heat from the sun imparted to the water in lower latitudes (the tropical regions of the ocean, such as the Gulf of Mexico, the Sargasso Sea, etc.), and transported with the warm surface currents, the Gulf Stream, the Brazilian Current, the Agulhas Current, etc., to the Arctic and Antarctic "centers" mentioned in the foregoing, where there takes place a transformation of the potential energy stored up in the system ice and salt water into kinetic energy, i.e. into acceleration of the current system raised by the ice melting, we infer from Carnot's principle that only a relatively small part of the heat stored up in the water is transformed into kinetic energy. According to this principle the condition for a continued transformation of caloric energy into work is that there shall be a *chute de chaleur*, i.e. a transit of heat from one center of higher temperature, T_1 (absolute), to another of lower temperature, T_2, and that the transformable part of the heat absorbed at T_1 and given off at T_2 is $(T_1 - T_2)/T_1$.

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[9] This hypothesis is of ancient date. It was developed mathematically into a physical theory by Zöppritz.

It has been shown in the foregoing that the principal centers where the heat imparted to the sea water in tropical latitudes is given off are situated in Arctic and Antarctic regions of the ocean. In the Atlantic the principal center of absorption of heat is the Sargasso Sea, from which warm currents and undercurrents are sent out to both hemispheres—the Gulf Stream to the northern hemisphere and the great undercurrent of warm water between 1200 and 3000 meters deep (see the diagram of Merz and Wüst, Fig. 2) to the South Atlantic and Antarctic.

Although that part of the radiant heat from the sun absorbed in the sea water which can be transformed into kinetic energy is relatively little and never exceeds one-tenth of the whole, it represents a considerable amount of work measured in horse power available for the acceleration and maintenance of the oceanic circulation.

Another part of the absorbed heat is given up to the air during the long transport from the tropical to the polar regions of the ocean and in the last instance is lost by radiation to space.

The amount of heat given up to the air—which with rare exceptions is always colder than the ocean—serves to maintain a similar thermodynamic cycle in the atmosphere consisting in the transformation of heat by evaporation of aqueous vapor which condenses to rain, fog, and snow. The thermodynamic cycle of the water in the atmosphere differs from that in the hydrosphere in that it is shorter, the condensation of the vapor taking place wherever the moist air rises and expands on encountering cold currents of air or mountains, while the solar heat stored up in sea water ordinarily first meets its transformation after a transit of some thousand miles to the ice-filled parts of the ocean.[10] The heat which the warm water loses by evaporation during transport is used in the atmospheric cycle to generate atmospheric disturbances which, as cyclones, rise and take their pathway over the North Atlantic following the trend of the westerly winds.

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[10] Some months ago two French physicists proposed to use the thermodynamic cycle of transformation of solar heat in sea water for economic purposes by the artificial shortening of its circuit. Hydrographic soundings have shown that 600 meters below the surface of the Sargasso Sea, which has a temperature up to 28° C., there exists a cold-water layer of only 6° C. From a ship anchored in the Sargasso Sea they proposed to establish a more direct communication between the warm and the cold water layers than that which exists in nature by means of a tube which should bring up cold water of 6° that would serve to condense the vapor generated *in vacuo* from surface water of 28° in a boiler.

THE CHANGES AND THEIR CAUSATION

We have found that the distribution of solar energy on earth—as well as its storage and transformation into work—is ruled by two thermodynamic cycles, one belonging to the hydrosphere, the other to the atmosphere.

In both cases the greater part of the heat absorbed at the higher temperature, T_1, is not transformed into work but is given up to the sea or the air in higher latitudes at a lower temperature, T_2. In the ocean a great part of this energy is consumed as latent heat in the melting of ice. In the atmospheric cycle only a minor part is restored to the air by the condensation of aqueous vapor as rain and snow upon the mountains of the continents, which act as condensers upon the humidity of the air just as the ice in the polar seas attracts the warm water of the ocean.

This indraft of warm air from the sea saturated with humidity sweeps over the continent of Europe in winter as a thin sheet of warm clouds, in most cases remnants of cyclones generated over the ocean which have lost their contact with that source of humidity. The climate of northern Europe largely depends upon this supply of heat and humidity from the ocean which passes overhead at an average height of 800 to 1800 meters, recorded as "inversions of the air temperature" in the registers of the meteorological stations at Lindenberg, Breslau, Petrograd, and elsewhere.

It is evident that every change which occurs in the régime of the oceanic circulation of the North Atlantic influences the climate of Europe. The same is the case—perhaps in a still higher degree—with the climate of the continents bordering on the South Atlantic, the Indian, and the Pacific oceans, which depends on the development of the current system of the Antarctic Ocean and in the last instance on the ice melting and the cold water generated by that process. At the beginning of this paper I gave instances of some exceptional conditions. I now pass to the question of the periodicity of such conditions. This I have tried to trace to planetary influence, i.e. to changes in the tidal force caused by the position of the earth relatively to the sun and the moon.

CAUSATION OF PERIODICITY

In discussions of tidal phenomena the waters of the ocean have hitherto been treated as a physically homogeneous medium in which the movement of the deep water under the influence of external forces must be of the same order with regard to time and space as that of the surface water. This is not so. The water of the ocean consists of different and well-defined layers with regard to temperature, salinity, and density which can move independently of one another hampered only by the drag or friction exerted by one layer upon another. This differentiation of sea waters is nowhere more pronounced than in the Scandinavian seas, where water layers from widely different parts of the Atlantic are found superposed upon one another with their limits so well marked that by analysis and by recording instruments their surfaces of contact can be located within a few decimeters.[11]

These boundary surfaces are liable to great changes of level which appear as huge submarine waves showing the periodicities of the parallactic tidal force. Not only the monthly and half-monthly but also the longer periods, annual, etc., appear well marked in the records kept during a series of years at Bornö, the Swedish hydrographical station in Gullmars Fjord. In ice-filled parts of the ocean they must exert an influence on the ice-melting process because they bring the ice floes and icebergs in contact with the warm and salt water below. Under ordinary circumstances the polar ice on the continental shelf of Greenland and of the Antarctic continent floats in cold diluted sea water in which the ice melts slowly, but when the submarine waves of the warm and salt deep water with enormous amplitudes—hundreds of meters and more—impinge upon the shelf at the spring tide of the parallactic tide, ice melting sets in on a grand scale. Even the Antarctic ice barrier, of which at least the outer part is in a floating condition, bursts and sends out icebergs and floes which reach farther northwards than usual and carry with them cold Antarctic water into the Indian, Atlantic, and Pacific oceans. Such catastrophes occur when the phases of the synodic, tropic, anomalistic, and draconitic periods of the moon coincide at the constellations of the perihelion apside of the moon's orbit (nearly 9 years); the saros, or coincidence of the synodic, draconitic, and anomalistic months (nearly 18 years); and multiples of the saros as 36 years (the so-called "Brückner period"). That outbursts do not occur more regularly, or in one and the same ocean or part of the ocean[12] we must ascribe to the fact that the epochs of the tropical month do not as a rule coincide with those of the others. When that happens, i.e. at the period of the perihelion node apside (about 1850 years), the disturbance caused by the polar currents becomes catastrophic, as in the fourth and fifth century before Christ, that is at the end of the Bronze

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[11] I have treated this phenomenon in a number of papers in several journals and in the *Svenska Hydrografisk-Biologiska Kommissionens Skrifter*, Nos. 1–7.

[12] The "saros" of the Chaldeans is usually regarded as an eclipse period without reference to its influence on the tidal force. Just as the optical effect of the constellation that brings an eclipse is not repeated after a saros on the same longitude and at the same hour with regard to the track of the sun's or the earth's shadow, its physical effect and aftereffects which will last for years do not fall on the same ocean or in the same hemisphere.

Age, or in the fourteenth and fifteenth century of our era when Greenland was blockaded by the polar ice drift and became inaccessible and uninhabitable to the Norsemen who had settled there 500 years before in the Viking Age.

The coincidence of outbursts of Arctic and Antarctic ice with such constellations is remarkable. In the perihelion apside of 1903 the position of the moon's orbit was analogous but not the same as in 1894, and there occurred the remarkable outburst of Arctic ice that so disastrously affected our northern fisheries. Nine years afterwards, in 1912, the perihelion apside was coincident with the last great ice year of the Labrador Current memorable for the disaster of the *Titanic*.

All these constellations are of the type which have been denoted as perihelion apside which brings a secondary maximum of the tide-generating force and, if we may judge from our experience of all known cases, outbursts of ice from the polar seas. The question of what happens at the important epochs of absolute maxima of the tidal force ruled by the constellation perihelion node apside, such as occurred about 500 B. C. and 1434 A. D. I have discussed in a paper, "Climatic Variations in Historic and Prehistoric Time."[13]

The Last Outburst of Antarctic Ice

I will now return for a moment to what occurred in the third decade of this century inaugurated by the constellation of the perihelion apside of 1921. In his account of the deviation of the Humboldt Current in 1925 Mr. Murphy quotes Dr. H. H. Clayton on changes in solar heat radiation as a possible cause of the phenomena. I agree in the view that the ultimate cause must be of cosmic nature, but I think that we have to do here with periodic changes of gravitation rather than of radiation and that we have to seek the proximate cause in the outburst of ice from the Antarctic shelf which is the cradle of all world-wide disturbances in the current system of the globe.

The rhythmical increase and decrease in the intensity of the tide-generating force culminating at the perihelion of the earth and the perigee of the moon exerts its influence upon the internal (and parallactic) tidal waves of the ocean which impinge upon the Antarctic shelf and cause outbursts of ice floes and icebergs and ice melting on a grand scale. This flow of cold Antarctic surface water spreads to lower latitudes and reinforces the three great currents—the West Australian Current in the Indian Ocean, the Humboldt Current in the Pacific, and the Benguella Current in the Atlantic—which have their origin in the South Sea either all together or separately. The rotation of the earth imparts to these currents a tendency towards deviation. The deviating force is $D = 2 \nu \omega \sin \phi$, where ν denotes the velocity of the current, ω the angular velocity of rotation of the earth, and ϕ the latitude. An acceleration in the flow of the current therefore increases the deviation, provided that counteracting influences—the ice-melting process and the turbulent friction of the current against the continental slope—remain constant. In the southern hemisphere this deviation is directed westwards, i.e. in this case away from the continental shelf of America and Africa which, as Mr. Murphy says, opened the way for the warm surface water assembled in the bight of Panama (and, we may add, in the Gulf of Guinea) to expand southwards along the South American (and African) coast.

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[13] *Svenska Hydrogr.-Biol. Komm. Skrifter*, No. 5. Discussed by Ellsworth Huntington: Climatic Variations and Economic Cycles, *Geogr. Rev.*, Vol. 1, 1916, pp. 192–202. See also Otto Pettersson: Innere Bewegungen in den Zwischenschichten des Meeres und der Atmosphäre, *Nova Acta Reg. Soc. Sci. Upsaliensis*, Ser. 4, Vol. 6, 1923, No. 2, reviewed by C. F. Brooks, *Geogr. Rev.*, Vol. 15, 1925, pp. 690–691.

The cause of this increase in the velocity of the Humboldt and the Benguella currents I find in the outbursts of Antarctic ice which, according to the few existing reports, began in 1921–1922. When this ice reached the warmer and salter water outside the Antarctic shelf a greater amount of cold and diluted surface water than usual was generated by ice melting to spread in a northerly direction both in the Pacific and the Atlantic oceans. The observations of the German expedition with the *Meteor*, cruising in the sound south of Cape Horn in January, 1926, where the salinity ordinarily is higher than 34 per mille (according to G. Schott), bear out the fact that the salinity of the surface water in that part of the sea then was unusually low, less than 34 per mille.

PEARY'S MARCHES

ON HIS NORTH POLE EXPEDITION, 1909*

Gunnar Isachsen

IN 1908–1909 Peary made his third and last attempt to reach the pole. On September 5, 1909, he wired from Indian Harbour, Labrador, that he had gained it. This declaration was received with doubt, which has continued ever since especially among the great public.

The National Geographic Society in Washington appointed in the autumn of 1909 a committee to examine the question: Chief Geographer Henry Gannett, Admiral Colby C. Chester, and Superintendent O. H. Tittmann—all men well qualified to judge in the matter. After careful examination of the instruments, observations, and log books belonging to Peary and all members of his expedition, the committee arrived at the decision that Peary had reached the North Pole April 6, 1909, adding that the journey was planned and executed by Peary in a manner worthy of the highest praise.

But one thing this committee was not competent to judge, and that is the length of Peary's marches. It is on just this point that doubt arose. That the doubt should continue is quite natural, as none of the few persons who understand this aspect of the matter has given an opinion, so far as I know. That is why I write these lines. And I write now because this doubt has again been raised in the press in connection with the last polar voyages of Amundsen and Byrd.

Peary's Marches

In 1908 Peary had taken his ship, the *Roosevelt*, to Cape Sheridan, in latitude 82° 27′ N. All the members of the expedition were on the trail the entire winter, hunting or sledging to establish depots northwestwards towards Cape Columbia, 83° 7′. On February 28, 1909, Captain Bartlett began his sledge journey from Cape Columbia with the first group. The following day they were all out on the ice, Peary last, and on their way northwards—in all 24 men, 133 dogs, 19 sledges, with provisions and outfit for 50 days. The distance to the pole from Cape Columbia is 413 nautical miles.

The objective of each day was to reach the pioneer party's camp before the group went further. The parties bunched together the fourth march when the ice broke up in leads during a gale that lasted several days, blowing first from the east and then from the west. For six days they were forced to wait before they could again advance. "Altogether I think that more of mental wear and tear was crowded into those days than into all the rest of the fifteen months we were absent from civilization."[1]

The first support party under Dr. Goodsell turned back March 14 at 84° 29′ N.; the second party, under Borup, March 18 at 85° 23′ N.; the third party, under Marvin, March 26 at 86° 38′ N.; and the fourth and last support party, under Bartlett, April 1, at 87° 47′ N.

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* Major Isachsen discussed this problem on a recent visit to the American Geographical Society and prepared the following translation from his paper "Har Peary vært ved Nordpolen?" *Norsk Geogr. Tidsskrift*, Vol. 1, 1926, pp. 100–104.—Edit. Note.

[1] Robert E. Peary: The North Pole, New York, 1910, p. 228.

From Cape Columbia to the place where Bartlett turned back the daily advance averaged about 12 miles; in the last eight days before Bartlett turned back the marches were about 17 miles. The support parties were consequently used up to the first of April, to 87° 47′ N., a point 133 miles from the pole. From this point Peary went to the pole with the negro Henson, 4 Eskimos, 5 sledges, 40 dogs, and provisions for 40 days. On April 6, at 10 a. m., Peary, according to his observation, reached 89° 57′ N. The last 133 miles (in a direct line) after he parted from Bartlett were done in five marches consequently averaging about 26 miles per day, with 10 per cent added for irregularity of the trail. During his stay of 30 hours at the pole, till April 7, 4 p. m., Peary followed a triangular course, with eight to ten miles to a side, taking at two of the angles observations of the sun in three different directions and at four different times. After these observations the pole was said to be situated at a place within the sides of this triangle. The return to Cape Columbia, where Peary arrived on April 23, was accomplished in sixteen marches, averaging about 29 miles.

Now comes the question: Is it not curious that Peary was able to sledge so rapidly after he had parted from Captain Bartlett, curious that he could do marches averaging about 29 miles from this point to the pole while his marches the last eight days up to 87° 47′ were only 17 miles and he had only averaged about 12 miles from Cape Columbia?

We know that the greater the party the greater the chance that something will go wrong or that the party will be hindered for one reason or another. For instance, a regiment cannot make as good marches as the best company of the regiment, and this company cannot make as good marches as some few picked men of the company. Peary's party on the final spurt for the pole—clearly the most intensive part of the whole expedition—was reduced to 5 picked men and 40 picked dogs. The party was under his personal leadership. He himself was at the head, and all of the party had a feeling that now the moment had arrived when all were to do their best to reach the goal. Therefore the final dash was quick. It had to be quick.

That the return journey from the pole could be rapid and had to be rapid is natural. It was important to reach land before the next full moon, May 3, in order to avoid the obstacles of leads and ice-crushing during the spring flood. Every day the sledges grew lighter and lighter, the snow houses built on the outward journey were of good use, and Peary could follow their old trail, a thing that is of great importance when sledging with dogs. From the moment when Peary parted from Bartlett until the journey was finished the pole party had good, quiet weather and therefore were not much hindered by open leads.

Several of the white members of the expedition had had previous Arctic experience, but the deciding factor during the whole trip to the pole was the help of the Eskimos, capable dog drivers as the Smith Sound Eskimos are. In all, Peary had taken with him from Smith Sound northwards from Cape Sheridan 22 men, 17 women, 10 children, and 246 dogs. He had the best personnel and material that could be procured, and his own experience as an Arctic explorer was second to none.

Comparison with "Fram" Expedition Marches

In giving my personal opinion with regard to the reasonableness of the length of Peary's marches I will compare his results with our own results during the second *Fram* expedition (1898–1902) under Sverdrup, of which I was a member.[2] After what I have said about Peary's technique, I have only to describe the ice as Peary encountered it and as we found it on the *Fram* expedition in our field of work west of Ellesmere Island and Grant Land.

From Cape Columbia northward to about 86° N. Peary sledged over old ice badly crushed. From this "paleocrystic" ice he entered a belt with many great leads. This belt of leads had stopped him in 1906 when the weather and ice were so unfavorable. From this disturbed belt—the "Big Lead," as Peary termed it—he reached ice of another character, young or "Atlantic" ice, which was not so crushed and piled up and therefore was easier to sledge over.[3]

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[2] Otto Sverdrup: New Land: Four Years in the Arctic Regions, 2 vols., London, 1904.

Several explorers have observed that the ice has another character to the east of Cape Bridgman, the northernmost point of Greenland. To the north of this point the ice is easier to sledge over than that along the northwestern coast of Greenland. This "Atlantic" ice is driven to the east towards the Greenland Sea. But the ice that is pressed against the north coast of Greenland west of Cape Bridgman, against Grant Land, and the islands to the west of Grant Land cannot easily be forced southwards through the narrow sounds between. The ice often lies in these regions year after year, exposed to a heavy pressure, until it becomes paleocrystic. It was this sort of ice that Peary passed through up to 85°–86° N., and it was the same sort of ice that we had to sledge over during the *Fram* expedition and which gives a basis for comparison.

On the second *Fram* expedition we were out sledging during about half of every year for four years. We had not only to sledge but to map and do every sort of exploratory work. But the only object of Peary's journey was to push northward towards the pole. His only concern was to make the longest possible marches northwards. In other words, Peary was exclusively a record breaker.

On our sledging trips we were not content with marches under 15 miles. We often made 20 to 30 miles, and marches of over 30 miles were not rare. Several times we even made marches of over 70 miles. Such long marches show that the sledging is easy and that the distance is eaten up in the good humor of the party and dogs.

If we could make such long marches over ice which may be supposed to have been about the same kind as the ice on the most difficult part of Peary's journey, then even longer ones may be made on better ice such as that which Peary met on his journey to the pole in 1909 to the north of the "Big Lead." It is my opinion that marches of the length of Peary's on his North Pole expedition of 1909 are possible not only for parts of the trip but for the entire journey.

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[3] See "The Geography of the Polar Regions," *Amer. Geogr. Soc. Special Publ. No. 8*, pp. 134–135; also on Arctic ice in general in "Problems of Polar Research," *Amer. Geogr. Soc. Special Publ. No. 7*, pp. 91–141.

MEANDERS IN TIDAL STREAMS: A REVIEW AND DISCUSSION*

Douglas Johnson
Columbia University

IN a recent bulletin of the Geological Society of America Mr. Marius R. Campbell presents an interesting discussion of the origin of meanders in tidal streams. In the words of the author the main object of his paper is "to demonstrate the proposition that the action of running water at sea level is very different from what it is above that level." Attention is directed first to the well known fact that the lower Mississippi is remarkably free from meanders. As to the cause of the relatively straight course below Baton Rouge, described as occupying a position "at or below" sea level, the author regards the problem as highly complicated and involved; but he is inclined to believe that when the river reaches tide level it flows between banks of stagnant water instead of between banks of earthy material and hence fails to corrade effectively.

Turning to the San Jacinto River of Texas, the author cites the remarkably fine examples of crescentic meander "scars," or scarps cut in the valley walls bordering the drowned lower course of this stream, and recognizes that these scarps were cut by the normal current of the meandering stream when the land stood higher. A later subsidence partially drowned the valley and checked the tendency of the river to enlarge its meander curves. In similar manner the drowned lower course of the James River, also bordered by meander scarps, is cited as an example of a stream which practically ceased its meandering habit when submergence caused the river current to flow through the relatively stagnant waters of the embayment. Here the fact that meander scarps bordering the embayment are no longer being cut by the river current is supported by elaborate argument. It is concluded that in the lower San Jacinto and in the lower James, just as in the lower Mississippi, a stream flowing at tide level has no tendency to form meanders or to cut off meanders formed at some previous period under conditions different from those of the present. The arguments and conclusions are then used in interpreting the geomorphic history of the lower James River and of the lower Potomac River in the vicinity of Mount Vernon.

The reader will follow with interest, and probably without substantial dissent, the author's interpretation of the river histories last referred to; he will enjoy following the arguments with the aid of the excellent sketch maps, especially as the author has made this easy by indicating in parentheses numbers or letters which make possible quick identification of all critical points; and he will give to arguments and conclusions that careful consideration which anything from the pen of Mr. Campbell always commands. Yet he may lay down the paper with doubt both as to the method of argument employed and as to the validity of the chief conclusion reached.

Lower Mississippi Compared with San Jacinto and James

One prefers when possible to reason from things easily demonstrated to those more difficult to understand. The lower courses of the San Jacinto and James rivers

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*Marius R. Campbell: Meaning of Meanders in Tidal Streams, *Bull. Geol. Soc. of America*, Vol. 38, 1927, pp. 537–556.

present no difficult physiographic problems in so far as concerns the partially drowned meander scarps and their significance. It has long been recognized that if a river valley like that shown in Figure 1 be partially submerged, the sea may come to rest against the crescentic meander scarps shown in Figure 2. The lower San Jacinto, the lower Seine, and other embayed streams have been cited as illustrations of valleys of former meandering rivers partially submerged by a change in the level of land or sea. When a river enters the relatively stagnant waters of a broadening estuary due to such submergence, its current, no longer confined to a narrow channel but free to take a more direct route to the sea, will abandon the outside of its meander curves and flow down a shorter and steeper slope. Such a current, bordered on either side by relatively stagnant water, ceases to corrade the estuarine shores.

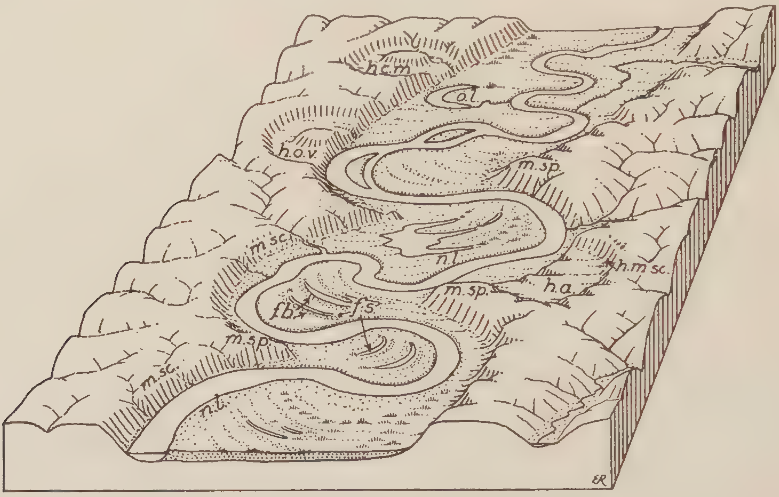

FIG. 1—Block diagram of a meandering river. Abbreviations: m.sp., meander spur; m.sc., meander scarp; f.b., flood-plain bars; f.s., flood-plain swales; n.l., natural levee; h.a., high-level amphitheatre; h.m.sc., high-level meander scarp; h.o.v., high-level oxbow valley; h.c.m., high-level cut-off meander spur; o.l., oxbow lake.

If, then, we begin with the simple cases of the San Jacinto and James, the next step is to apply the principles easily demonstrated there to the more problematic lower Mississippi. But this step can be taken only if the physical conditions in the several cases are substantially identical. In the reviewer's opinion the physiography of the lower Mississippi has little in common with that of the two other streams. After all, the lower San Jacinto and lower James are rivers only in name; physiographically they are bays of the ocean, in whose expanded waters unconfined and much diffused river currents move where inertia and gravity lead them. What analogy have they with the lower Mississippi, a true river with its current rather closely confined by earthen banks?

Relation of River Levels to Sea Level

If rivers meander extensively above a certain level, and not at all below that level, the limiting plane should be defined with precision. The author apparently uses the terms "sea level," "tide level," and "tidewater" as synonymous, although these terms are commonly applied to different things, which do not necessarily have the same level. That the difference in level is vital to the author's argument appears clearly in the next-to-the-last paragraph of the paper, where he excludes meandering runways in tidal marshes as having little or no bearing on this subject, because any lateral cutting effected by the incoming and outgoing tides would be done "above actual sea level." We may assume that here the author has in mind the definite plane of mean sea level and believes (which the reviewer does not) that tidal currents do all their lateral cutting above that plane. Would the author regard sea water moving through these runways with the tides as not within the limits implied by such expressions as "tidewater" and "tide level"? One has an uneasy feeling that perhaps meandering tidal creeks demonstrate the ability of streams, under proper conditions, to meander at tidewater or tide level (both above and below mean sea level) and hence that they may constitute a serious objection to the acceptance of Campbell's main conclusion.

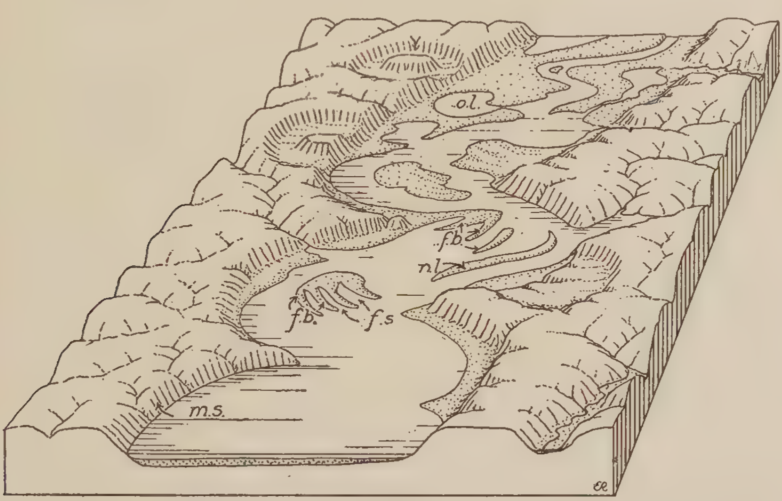

FIG. 2—Block diagram of a drowned meandering river. Abbreviations, referring to features partially drowned: m.s., meander scarp; f.b., flood-plain bars; f.s., flood-plain swales; n.l., natural levee; o.l., oxbow lake.

If the reader feels that in the matter of meandering tidal runways the author has too summarily dismissed what appears to be an important phase of the problem, this feeling is apt to be reënforced by other parts of his text. James River is recognized as "a tidal stream from Richmond to Hampton Roads, but from the head of tide down nearly to City Point, at the mouth of Appomattox River, the stream behaves more or less as a normal river behaves, and the drowning is not sufficient to submerge the flood plain and carry the water far inland beyond the immediate banks." All this is true of the lower Mississippi; yet the tidal portion of the James here described has good meanders, whereas the lower Mississippi has not. Only low-water elevations are given for the Mississippi; yet it is admittedly during high water that the lateral corrasion of the stream is most effective. At such times the tidal portion of the river is above actual sea level more truly than are the waters of meandering tidal runways.

Gradual Change in Physiography of Lower Mississippi

The change in the behavior of the lower Mississippi does not take place abruptly. Reference to the Mississippi River Commission's maps will show that, while north of Baton Rouge the river shows many meanders and cut-offs, below this point meanders are still pronounced, although evidences of cut-offs are rare or wholly lacking. Near Donaldsonville the pronounced meanders gradually give place to a pattern characterized by simple bends rather than by true meanders. Not far below New Orleans the simple bends die out, and the remainder of the river's course is for the most part relatively straight or only faintly sinuous. Perhaps it would be most accurate, and likewise most significant, to say that the river changes somewhat gradually from a meandering to a non-meandering course, the three places named being arbitrary division points which serve to emphasize the extent of the progressive change. Any satisfactory theory to account for the non-meandering character of the lower Mississippi must take account of the facts that the change in the river's behavior is progressive and is effected above, not at or below, mean sea level, if due account be taken of the high-water stages. At Baton Rouge high water is approximately 40 feet, near Donaldsonville 30 feet, and a little below New Orleans 18 feet above mean sea level. Incidentally it may be noted that the river is tidal well above Baton Rouge during low-water stages, whereas at high water the tidal influence is scarcely perceptible at Donaldsonville.

If Baton Rouge be selected as the most significant point along the course of a river which alters its pattern gradually, then it is important to note that above and below this point there are contrasts in physical conditions which may be more significant than the one emphasized by Campbell—position of low water with respect to sea level. Some of these differences Campbell has touched on but without complete analysis of their possible relations to the present problem. Other differences may be worthy of consideration, sucn as those in river slope, in velocity of current, in direction and position of current as affected by tides, in proportion of salt water present, in average depth of channel and its possible relation to geologically recent coastal subsidence, and in the nature, height, and slope of the containing levees. Davis has suggested that the extreme tenacity of the mud forming the channel and banks of the Lower Mississippi may retard meandering there, while Powell earlier advanced the idea that near its mouth the silt borne by the river is too fine to serve as a corrading agency. It is possible also that the progressively more recent age of the lower and straighter portions of the river deserves more favorable consideration than Campbell has given this point, especially in view of the probability that sluggish rivers initially nearly straight require an immensely long time in which to develop their first meanders.

Need of Comparison with Other Streams

Concurrently with consideration of these elements of Mississippi physiography attention should be directed to other tidal rivers which reach the sea without passing through relatively stagnant water of a broadening estuary.[1] The examination should include streams like Maurice River in New Jersey, which meanders extensively where it traverses salt marshes; streams like the Combahee of South Carolina, which meanders through the salt marshes of its lower course and the fresh swamps farther up and in both places apparently with normal vigor, although tidal in both; streams like the Indus, where marked meanders and occasional oxbow lakes appear to exist in the lower, tidal portion, whereas the non-tidal portion immediately above (before the extensively braided section is reached) seems to have a relatively simple pattern, thus reversing the conditions found in the Mississippi case; and other variable types of meandering tidal streams. From such a study there might emerge a satisfactory explanation of the varying behavior of all such streams.

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[1] While the present article was in galley proof an excellent study of this type appeared in the *Journal of Geology* for October–November, 1928, pp. 615–629, under the title "Meandering in Tidal Streams." The author, Dr. Donald C. Barton, shows that meandering with cut-offs occurs in the tidal Brazos River, Texas, and discusses a variety of conditions which may affect meandering both above and at sea level.

A Problem of Terminology

In conclusion it may be pertinent to refer briefly to a problem of terminology. Campbell proposes to apply the name "meander scar" "to any scar that marks the position of a former meander, whether it be on the upland or on the flood plain of the stream." This proposal will interest those who believe that the growth of geomorphology should be accompanied by increasing precision in the use of terms employed in the science. So far as the reviewer is aware, former positions of river meanders are seldom indicated in the topography of an upland surface, for the reason that this ancient element of the landscape has usually been too long exposed to the effacing action of weathering and erosion. Below the upland surface, more or less deeply incised in the land mass but still above the level of present flood plains, are frequently found traces of former meanders, including abandoned oxbow-shaped valleys, old cut-off meander spurs, and high-level amphitheaters open toward the valley lowland. On the present flood plain more recent meander paths are attested by oxbow lakes, crescentic marshy swales and ponds, crescent-shaped bars of sand, as well as by crescentic scarps cut in the valley wall. If the term "meander scar" is to be applied to all these features marking the positions of former meanders, then we must employ other terms to differentiate the various types of meander scars. The accompanying illustrations (Figs. 1 and 2) show a terminology, based for the most part on usages of earlier writers, which the reviewer has found serviceable.

THE STUDY OF PLACE NAMES
RECENT WORK AND SOME POSSIBILITIES

John Kirtland Wright

THE many methods which have been followed in studies of geographical names might be grouped under two general heads: (1) accumulative and (2) "ecological."

The accumulative methods are not unlike those of the botanical collector, whose first interest is in gathering and ticketing specimens. The toponym collector draws up lists of place names and garners details regarding the origin and meaning of each;[1] he is concerned primarily with the individual name.

The "ecological" methods—if we may borrow this term from biology—are those in which investigation is made into the nature of the geographical nomenclature in the large and more especially in its relation to the environment, past and present, physical and human. Interest in this case is not confined to or centered upon the individual name.

AMERICAN STUDIES OF PLACE NAMES

If we may judge from the published literature, the majority of American studies of geographical nomenclature belong essentially in the first category; they have been works of collection and classification, and the results have frequently been presented in alphabetical order. For instance in 1902 Henry Gannett published a 264-page list of selected names of both natural and cultural features in all parts of the United States.[2] As a dictionary of American toponym origins this work is a classic. Immense care was devoted to its compilation. The author carried on an extended correspondence and combed a multitude of publications, the titles of which he gives in a useful bibliography. But he made no attempt at synthesis, and the historical notes are extremely brief. Similar compilations cover particular regions or types of name, as, for instance, E. S. Meany's[3] and Lewis A. McArthur's[4] annotated lists for Washington and Oregon and F. P. Farquhar's study of the place names of the High Sierra.[5]

However, some attempts have been made at analysis and interpretation of various phases of the nomenclature. Even when the main part of a study has taken the form of a listing and commentary upon individual names the author has generally supplied a broader explanatory introduction. Whenever this has been done we have the rudiments of an "ecological" study. Among recent American examples we may mention von Engeln and Urquhart's "The Story Key to Geographic

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[1] Two important examples of earlier studies are: J. J. Egli: Nomina geographica: Sprach- und Sacherklärung von 42000 geographischen Namen aller Erdräume, 2nd edit., Leipzig, 1893, and the less ambitious work of Isaac Taylor: Names and their Histories, Alphabetically Arranged as a Handbook of Historical Geography and Topographical Nomenclature, New York, 1896. These are useful alphabetical lists of geographical names with discussions of their origins. Egli appends bibliographical references.

[2] Henry Gannett: The Origin of Certain Place Names in the United States, *U. S. Geol. Survey Bull. 197*, Washington, 1902.

[3] E. S. Meany: Origin of Washington Geographic Names, Seattle, 1923 (also published in the *Washington Historical Quarterly:* Vol. 8, 1917 to Vol. 14, 1923.)

[4] L. A. McArthur: Oregon Geographic Names, Portland, Ore., 1928. See also *Quarterly of the Oregon Hist. Soc.*, beginning Vol. 26, 1925, pp. 309–423.

[5] F. P. Farquhar: Place Names of the High Sierra, Sierra Club, San Francisco, 1926.

Names,"[6] Espenshade's "Pennsylvania Place Names,"[7] and Fitzpatrick's "Nebraska Place-Names."[8] A brief discussion by W. A. Read, "Research in American Place Names, c. 1920–26: a Partial Review," has recently appeared.[9]

THE ECOLOGY OF THE PLACE NAME COVER

We have used the term "ecological" in this connection because there is an analogy—not perfect, by any means, but striking enough—between the vegetation cover and what we might conceive to be a place name cover spreading over the landscape. Just as many plant formations contain a gradation of elements between those that are just becoming established and those that are dying out, so we have for any given region a group of names that are coming into use, others that are fully accepted, and still others that are disappearing. There are also names that might be called dead—that is, that have been completely abandoned in local usage and are found only on old maps or in other records.[10]

The living names in any particular district at any particular time are an accumulation from the past, the quality and the density of which depend partly upon the density of the population, partly upon the length of time during which the country has been occupied and upon the character of the various waves of settlement that have swept through it, and partly upon the nature of the ground. If the topographical aspect of a region or the character of the population and language spoken within it changes materially there will be a corresponding alteration in the name cover. This alteration, however, is likely to be exceedingly slow. European experience has shown that a place name, once established, is often even more enduring than a nation or a language. On July 3, 1790, a group of classical names was officially bestowed by the Land Office in New York City upon twenty-five unsettled townships in western New York state: Lysander, Hannibal, Cato, Brutus, Camillus, Cicero, Manlius, Aurelius, Marcellus, Pompey, Romulus, Scipio, Sempronius, Tully, Fabius, Ovid, Milton, Locke, Homer, Solon, Hector, Ulysses, Dryden, Virgil, Cincinnatus.[11] Nearly a century and a half of ridicule has not sufficed to remove these names; and it is probably safe to predict that, like the many pre-Celtic toponyms still in use in France[12] and England, they will persist—modified in form, to be sure—even when the English tongue itself has become one of the dead languages.

The place name cover in western Europe is very dense and its interpretation extremely complicated. Development has been proceeding through so long a period and has reflected so many linguistic and historical changes that origins and original meanings are often obscure or inexplicable. In the United States, on the other hand, since in most cases we possess the records of the early settlers who applied names to administrative subdivisions and natural features, the problem is simpler. Our names, except those bestowed by Indians, French, and Spaniards, have not been subjected to radical changes in their linguistic environment. The interpretation of Indian names, however, demands highly technical knowledge, especially because many of these aboriginal designations have undergone violent transformations during the centuries that they have been maltreated on the tongues of white men.[13] "Kearsarge" and "Connecticut," for example, represent words originally pronounced in some such manner as *koowass-adchu* and *quinni-tuk-ut*.[14]

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[6] O. D. von Engeln and J. M. Urquhart: The Story Key to Geographic Names, New York and London, 1924. A book for children, intended to enliven the study of geography by giving explanations of the principal geographic names employed in all parts of the world.

[7] A. H. Espenshade: Pennsylvania Place Names, State College, Pennsylvania, 1925. Entertaining historical notes on the origins of county, town, and village names, with a brief classification.

[8] L. L. Fitzpatrick: Nebraska Place-Names (Univ. of Nebraska Studies in Language, Literature, and Criticism, No. 6), Lincoln, Neb., 1925. Brief notes on origins of town, village, railroad station, and post office names, arranged alphabetically by counties and preceded by a brief classification.

[9] *Zeitsch. für Ortsnamenforschung*, Vol. 4, 1928, pp. 185–191.

[10] Many abandoned names in the middle west are listed in [W. H. Stennett]: A History of the Origin of the Place Names Connected with The Chicago & North Western and The Chicago, St. Paul, Minneapolis, & Omaha Railways, Chicago, 1908.

[11] Charles Marr: Origin of the Classical Place Names of Central New York, *Quart. Journ. New York State Hist. Assn.*, Vol. 7, 1926, pp. 155–168.

[12] See *Geogr. Rev.*, Vol. 15, 1925, p. 658, à propos of Auguste Longnon: "Les noms de lieu de la France, leur origine, leur signification, leurs transformations," Paris, 1920–1923.

Stabilization of the Place Name Cover

In many parts of the United States the geographical nomenclature is not altogether established. Writing in the seventies of the nineteenth century, M. F. Sweetser in his guidebook to the White Mountains pointed out that different names were often given to a single mountain by people dwelling on different sides.[15] Such differences do not usually lead to bitter feeling, as in the case of the famous dispute between the inhabitants of Tacoma and Seattle about the name of the great mountain overlooking Puget Sound. But that there is still no little confusion in the White Mountains the writer knows from personal experience. Even the name "White Mountains" itself is flexible, the term frequently being applied by natives of northern New Hampshire and northwestern Maine to the highest (or Presidential) range only, whereas others who dwell at a greater distance extend the limits of the White Mountains over a wider radius. The influx of a new type of settler or visitor often tends to bring about changes in names, particularly when the newcomers are of a different educational and cultural background from the original settlers. City people coming to the White Mountains for the summer have often endeavored to substitute names more euphonious than those used by farmers and lumberjacks. The reaction of the urban type of mind to some genuinely rural names in New England was thus expressed by Sweetser: "Nomenclatural degradation is found in the various Hog-back Mountains, and the villainous names given to the fine peaks of the Ossipee Range, which are called the Black Snouts by the neighboring rustics."[16] By fiat of the U. S. Geographic Board the names of many of the mountains on Mount Desert Island have been changed.[17] Green Mountain, the highest summit, becomes Cadillac Mountain, Newport becomes Champlain Mountain, Robinson becomes Acadia Mountain, Brown's becomes Norumbega Mountain, and Dry becomes Flying Squadron Mountain. These artificially chosen names are thought to be more appropriate in a National Park than the homelier designations bestowed by the pioneers.

In the United States the carrying out of surveys, the publication of authoritative government maps, and the decisions rendered by the Geographic Board are exerting a powerful influence toward the fixation of the geographical nomenclature. Stabilization is also being promoted through a development of historical interest which leads to the investigation of old place names and active propaganda for their preservation.[18]

Social Basis of the Place Name Cover

The manner in which the geographical nomenclature may reflect the social character of the groups of people who have actually occupied a country and have created the name cover was discussed several years ago by Professor Whitbeck in an entertaining article on regional peculiarities of place names in the United States.[19] Whitbeck picked out several typical regions, comparing the character of the names in each and explaining the reasons for the differences. For example, such New England town names as Barkhamstead, Farmington, Hartford, Manchester, Glastonbury, etc., reveal a strong influence of old England and "evidence of both culture and character." The New England administrative system, under which the whole countryside is subdivided into "towns," led to the frequent use of adjectives, North, South, East, West, and Center, in designating the villages within each township—thus, East Lebanon, Center Lebanon, West Lebanon, or even East North Yarmouth. Such directional adjectives are not found in the South and West where the county was the fundamental administrative unit. A very different type of name is exemplified in northern New Jersey. Whitbeck writes of such "cool and balmy names" as Allendale, Bloomingdale, Pleasantdale, Maplewood, Wildwood, etc., which "spring up in profusion only in regions where city influence is strong." Such names were frequently applied in the first instance by real estate agents with a view to attracting urban dwellers into the suburbs. In Tennessee the limited imagination and education of the mountaineers has led to names like Arc, Aunt, Bee, Fry, Fly, Gum, Kate, Lucy, etc.

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[13] An exceptionally interesting study of the Indian place names and their relation to environment is that of T. T. Waterman: The Geographical Names used by the Indians of the Pacific Coast, *Geogr. Rev.*, Vol. 12, 1922, pp. 175–194.

[14] J. H. Trumbull: The Composition in Indian Geographical Names, Illustrated from the Algonkin Languages, reprinted from *Connecticut Hist. Soc. Colls.*, Vol. 2, Hartford, 1870, pp. 8, 20.

[15] M. F. Sweetser, edit.: The White Mountains: A Handbook for Travellers, 4th edit., Boston, 1881, p. 31.

[16] *Ibid.*

[17] Decisions of the United States Geographic Board, Oct. 2, 1908.

[18] See, for example, H. W. Shoemaker: Place Names and Altitudes of Pennsylvania Mountains, Altoona [1923?]. (Address at quarterly meeting of Wyoming Historical and Geological Society, Wilkes-Barre, Pa., March 9, 1923.)

Physiographic Basis of the Place Name Cover

To place name cover in relation to the earth's surface itself less attention has been devoted by American students than to its historical and social aspects. Comparative studies in the relative density, distribution, and quality of names in regions of varying topography would be well worth while. That there is a field here for investigations of considerable interest has been shown by European scholars.

For example, a way in which place names may preserve a record of former topographical conditions has been pointed out in a recent article by Wilhelm Troll, who reconstructs the probable distribution of the forests on the glacial soils in the vicinity of Munich before the Thirty Years' War largely from the evidence supplied by toponyms correlated with the terrain.[20]

The relative abundance of names, or density of the place name cover, depends upon a variety of circumstances. In thickly settled territory names are naturally abundant, but they are also profuse in districts that are frequently visited but not permanently occupied. Thus, to revert to the White Mountains, the highest peaks, tramped over every summer by climbers and tourists, literally bristle with place names, every ravine, every ridge, and many a boulder, cliff, and crag having its recognized designation. On the other hand, in the outlying mountains which are rarely visited except by loggers, fishermen, and berry pickers the names are more widely separated, and there are many prominent but quite nameless summits, ridges, and watercourses.

The minor topographical features to which permanent names are affixed vary in different parts of the world. Nearly everywhere bodies of water and the larger elements of the relief (hills, mountains, cliffs, etc.) are named.[21] On the other hand, there are great divergences in custom governing the use of names for the vegetational elements, such as forests, groves, meadows, pastures, moors, fields. In the eastern United States woods and forests rarely have acquired distinctive names—perhaps by reason of their often indefinite extent and their lack of permanence. In Europe, on the other hand, forests, copses, and woods, generally acquire enduring designations. If we examine one of the inch-to-the mile Ordinance Survey maps of the rural districts of England we note many names by which farms and estates have been known for generations. These names are part of the established place name cover. This is hardly true in the United States; property is usually spoken and thought of as "Robinson's" or "Smith's" even though Mr. Robinson may call his farm "Bonniebrook" on his letterheads and Mr. Smith may sell his apples or peaches under the trade name "Hilltop Farm."

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[19] R. H. Whitbeck: Regional Peculiarities in Place Names, *Bull. Amer. Geogr. Soc.*, Vol. 43, 1911, pp. 273–281. See also J. J. Egli: Der Völkergeist in den geographischen Namen, Leipzig, 1894. (Sonderabdruck aus dem *Ausland*, 1893.)

[20] See *Geogr. Rev.*, Vol. 17, 1927, p. 492, à propos of Wilhelm Troll, "Die Bedeutung der Ortsnamen für die pflanzengeographische Forschung" (*Zeitschr. für Ortsnamenforschung*, Vol. 2, 1926, pp. 12–31).

[21] For an interesting exception to this generalization, see Waterman, *op. cit.*

Nor are the natural or physiographic regions of the United States recognized by distinctive names, except occasionally by geographers and naturalists or where they present a striking contrast to neighboring regions —as in the case of the plateaus of the southwest, or the Black Belt of Alabama, Georgia, and Mississippi, or some of the prairies of Texas.[22] We have nothing analogous to the names of the *pays* of France, which, as Gallois has shown, correspond essentially to well-defined lesser natural regions.[23] A Frenchman may refer to the little town of Voves, southeast of Chartres, as either in Eure-et-Loire, or in Orléanais, or in the Beauce. The first is the name of the *département*, the fundamental administrative subdivision. On the whole, however, the departmental names are probably less frequently used in everyday speech than the provincial names dating from before the French Revolution (Orléanais, Bretagne, Touraine, etc.) or than the *noms de pays* (Beauce, Woevre, Argonne, etc.) The provincial and regional names, though officially obsolete and without governmental recognition, are living territorial designations of the different parts of France; and, despite more than 130 years of organization by *départements*, the latter are still generally regarded as artificial. To change our comparison from ecology to paleography, we might liken the territorial nomenclature of France to a palimpsest, in which the older names stand out distinctly beneath the superimposed layers of later administrative nomenclatures.

In the United States, on the other hand, our administrative subdivisions were usually established coincidentally with, or occasionally even before, settlement; and the administrative names are in most cases the only territorial designations in use. Thus there is no other way of referring to the town of Harvard except by relating it to existing administrative units. Thus we must say "Harvard lies in eastern Worcester County, in the east-central part of Massachusetts," even though this town stands upon a block of upland country which is fairly well defined by river valleys and which, were it in France, would doubtless have its own distinctive name.

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[22] See R. T. Hill: Geography and Geology of the Black and Grand Prairies, Texas . . . *21st Ann. Rept. U. S. Geol. Survey, 1899-1900, Part VII, Texas,* Washington, 1901, p. 26.

[23] Lucien Gallois: Régions naturelles et noms de pays, Paris, 1908.

AMUNDSEN: SUPREME ADVENTURER

John H. Finley

THE tragic end of Amundsen's terrestrial career was after all the most poetically fit and glorious that could crown such a life of exploration and adventure. A polar sea could alone give him appropriate sepulture. It was fit too that he should find his last sea grave near the shores of his Viking land. That he came to his death in seeking through the Arctic mists to rescue those who could not even be called "friends" makes his last voyage his supreme adventure. He who made himself doubly immortal in his conquest of both poles of the earth has added a third palm to his immortality.

Sir Thomas Browne, in his "Religio Medici," expanded Lucan's line "coelo tegitur, qui non habet urnam" into one that may most aptly be applied to him:

> He that unburied lies wants not his Herse,
> For unto him a Tomb's the Universe

Amundsen belongs to the universe in a particular sense. Not only did he attain the uttermost ends of the earth: but also those far older and yet more romantic objectives, the Northwest and Northeast Passages, from the search for which interest in the polar regions had first proceeded. While he followed Nordenskiöld in sailing the Arctic Sea eastward from Atlantic to Pacific he was actually the first to navigate that sea westward from ocean to ocean. What was the formula of his almost magical success?

"Exploration," he says in "My Life as an Explorer," "is a highly technical and serious profession." He saw it as an end in itself, and he brought it to high perfection. The requirements for this profession are "a sound and trained body" and a "specialized mental equipment." The latter, he continues, is "informed regarding the experience of all preceding expeditions." It is a notable commentary on one who spent so much of his life in the wilderness. "Secondhand experience out of books is often as good as firsthand, if the reader has had enough practical experience in the same field to understand and apply what he reads." Here is a basis of wise judgment. He made the Northwest Passage by following a suggestion gleaned from M'Clintock and taking a course through Simpson Strait, south of King William Island, a course rendered possible furthermore by his selection of a small shallow-draught boat: his vessel, the little *Gjöa,* was only 47-tons register. Best example of all is his choice of a base for the dash to the South Pole. The Bay of Whales, a stable point on the floating ice of the Great Barrier, was chosen "as a result of careful comparison of every existing description of that part of the Antarctic glacier, from its discovery." The difficulties encountered by Scott in his contemporary march farther west proved the wisdom of Amundsen's decision. It was the sound deduction, backed by the courage to put his theory to the test, that marks his feat as heroic. It is precisely like Nansen's test of his conclusions regarding Arctic currents by the drift of the *Fram.* Amundsen, indeed, was inspired by Nansen, whom he acclaims as a pioneer in the theory and practice of polar exploration. Nansen he followed specifically in his use of light equipment, of dogs for motive power, and of concentrated food for men and beasts.

The explorer by ship is advisedly a trained navigator. Amundsen recognized this asset at an early date and found justification for it in his own experiences as first mate on the *Belgica* in the Antarctic, 1897–1899. The explorer's equipment also should include "a thorough understanding of the scientific problems in the solution of which his explorations can have an essential part." Speaking of the preparation for the Northwest Passage, he says "My expedition must have a scientific purpose as well as the purpose of exploration. Otherwise I should not be taken seriously and should not get backing." In pursuance of this policy he undertook careful training in the study of terrestrial magnetism, with what admirable result is shown by his two-year series of magnetic observations from the vicinity of the North Magnetic Pole. Of similar order are the meteorological observations at Framheim, Amundsen's South Polar winter station, and the magnetic, meteorological, and oceanographical results obtained on the *Maud* during the Norwegian North Polar Expedition, 1918–1925 under the scientific direction of H. U. Sverdrup.

It was a rare combination this: painstaking purpose and scientific preparation fired by high spirit of adventure. Till the end came, as we must presume some time shortly after June 18 last, it carried through to unrivaled success this "supreme adventurer," as he is called by his friend and old comrade, Lincoln Ellsworth.

AMERICAN GEOGRAPHICAL SOCIETY

The November Meeting. The first regular meeting of the American Geographical Society for the season 1928–1929 was held on November 20, 1928, at the Engineering Societies Building, 29 West 39th Street, President John H. Finley in the chair. Mr. Herbert E. Bradley addressed the Society on "An Unknown Cannibal Country in the Belgian Congo." Mr. Bradley conducted an expedition (1924–1925) into the territory west of Lake Edward in the Belgian Congo. There he found primitive African life, untouched by civilization, and obtained an unusual set of motion pictures of the cannibal Bahuni as well as of the extraordinary animal life in which the country abounds.

Elections to Fellowship. At the November meeting of the Society, President Finley presiding, there were presented with the approval of the Council the names of 522 candidates who were duly elected as Fellows of the Society.

Presentation of the Samuel Finley Breese Morse Medal to Captain Sir Hubert Wilkins. At the last regular meeting of the Society for the season 1927–1928, held on April 24, the Samuel Finley Breese Morse Medal was awarded to Captain Sir Hubert Wilkins (*Geogr. Rev.*, Vol. 18, 1928, p. 496). At a luncheon on July 3 presentation of the medal was made by Mr. Philip W. Henry, Chairman of the Council. "We are here to honor a man experienced both in exploration and aviation," said Mr. Henry, briefly recapitulating Captain Wilkins' work up to the epoch-making flight.

"On April 21, 1928, the world was electrified to learn of the successful flight from Point Barrow to Spitsbergen, a distance of over 2000 miles, the greatest airplane achievement in the polar regions. As a feat in navigation, it is unexampled; for the proximity of the magnetic pole, the necessity of crossing at an acute angle so many meridians in high latitudes, and the small area of his island destination made the problem unusually difficult. But it was solved perfectly; and for his great achievement he has received the plaudits of the world—from the geographer and scientist to the man in the street. Like all true-hearted men, he gives due credit to those who made possible this successful outcome and has expressed in the most positive way how much he owed to the skill and courage of his pilot, Lieutenant Eielson, who is with us today. From a geographical standpoint this trip brought to view a lane of territory over 2000 miles in length, the greater part of which had never before been seen by the eye of civilized man. Although no new land was discovered, his path covered a section where there was a possibility of land and where Peary thought he had seen it.

"More than all, this trip demonstrated the soundness of the conclusions which our explorer had expressed in his article entitled 'Polar Exploration by Airplane' in the recent volume published by the American Geographical Society on 'Problems of Polar Research,' to which thirty-one experts on polar problems contributed. Such achievements are worthy of recognition, and there has been no lack of this on the part of European civic and scientific bodies, many of which have honored him with medals and other marks of favor. As an Australian he has been knighted by his King. The American Geographical Society was the first to pay tribute in the form of a medal available under a bequest made in 1872 (but not founded until 1902) by Samuel F. B. Morse, himself an explorer in the realm of electricity. In the words of the founder, the medal is to be presented 'for the encouragement of geographical research.' It is interesting to note that the first medal is given to one who used in 'geographical research' a means of transportation unknown in Morse's day and one which at that time was considered an unrealizable dream by many prominent scientists. It will also be observed that during his flight the explorer sent messages, transmitted through the air—an advance over Morse's invention—thus keeping the world informed of his movements.

"In view of the endorsement and support originally extended by the American Geographical Society, and in view of his great achievements, it gives me particular pleasure to present, in behalf of the Society, the Morse Gold Medal to our distinguished guest, Captain Sir Hubert Wilkins. In presenting you, Sir Hubert, with our medal we not only wish to do honor to the work you have done in the Arctic but to signify our confidence in your plans for the work that lies ahead of you in the Antarctic."

In responding, Captain Wilkins thanked the Society for its unfailing support of his Arctic work and presented it with an American flag which he had carried with him in his flight. Captain Wilkins then described in some detail his plans for further work in the Antarctic.

Recent Publications

Map of the Antarctic and Navigational Chart of the Antarctic. These maps have been designed to meet the needs of those who wish to follow current Antarctic exploration. Specifically they were prepared for use by the expeditions of Commander Richard E. Byrd and Captain Sir Hubert Wilkins, now in the field. The map of the Antarctic is on a scale of 1:4,000,000 and is printed in black and white and blue, in four sheets each 32 inches square. This size permits adequate representation of the known data. It incorporates the work of all the major expeditions of the last thirty years, among them those of Shackleton, Scott, Amundsen, the *Belgica*, Charcot, Mawson, Drygalski, Nordenskjöld, Bruce, and Filchner and, in so far as it has not been superseded, the work of the earlier explorers and seamen.

The known extent of the inland ice is shown and the glaciers at its margin, together with the shelf ice and the border of the free-swimming ice pack as observed by past expeditions. Relief of the inland ice and the small areas of ice-free land are shown by generalized contours at 1000-meter intervals; many individual heights are given and also the profiles of Amundsen's and Scott's routes from the Ross Barrier to the Pole, which are here reconciled for the first time. Dr. Simpson's conclusion that Scott's value (elevation of the South Pole 2765 meters, or 9072 feet) was a closer approximation to the truth is accepted. Practically all known soundings in Antarctic waters are represented on the map, while the more abundant data permit drawing of bathymetric contours at 200, 500, and 1000 meters and thence downward for each 1000 meters. Lines of equal magnetic variation are shown for 1927. The network of geographical coördinates is drawn for every degree to facilitate the plotting of new data as they are received.

The large scale and the use of color bring out very graphically how enormous is the area of Antarctica that is still quite unknown. Only narrow belts of territory have been mapped of a total land mass that is possibly twice as great as the United States. The two-thousand-mile stretch between Graham Land and Ross Sea is totally unknown; and, except for two landfalls, so is the whole opposite coast of the continent for nearly a third of the way round the globe in that latitude.

The Navigational Chart of the Antarctic, on a scale of 1:12,000,000, which accompanies the above map is made for use in aircraft navigation. It is identical with that supplied to Commander Byrd and Sir Hubert Wilkins. It shows the outlines of ice and land as far as known and the lines of equal magnetic deviation. Its use is explained in a pamphlet accompanying the maps.

Richard Hakluyt and the English Voyages. The Society announces the publication of a volume of this title by George Bruner Parks, Ph.D., Professor of English at Washington University, St. Louis. This is the first adequate life of the famous editor of the *Divers Voyages* and *Principal Navigations.* Hakluyt is shown to have been not merely a compiler of narratives of exploration and overseas ventures but a practical geographer and promoter of English colonial and mercantile enterprise. Geographical science in England in the Elizabethan Age is discussed in full. Dr. James Williamson, authority on English expansion in this period and author of a recent biography of Sir John Hawkins, has contributed a brilliant introduction.

Northern Neğd: A Topographical Itinerary. This volume, by Professor Alois Musil, is Number 5 of the Society's series *Oriental Explorations and Studies* (see *Geogr. Rev.*, Vol. 15, p. 297; Vol. 17, pp. 145, 178; Vol. 18, pp. 144, 497). It contains the narrative of a journey carried out in Nejd in the winter of 1915. Leaving Al-Jauf in January Musil skirted the little-known eastern margin of the Nefūd desert to a point about two hundred miles east-southeast from Ḥāyel. Here he spent some days in extremely hazardous but unsuccessful political negotiations with the young Shammar emir, Sa'ūd ibn Rashīd. Thence Musil made his way west to Al-'Ela' on the Ḥejāz Railway and from there eastward again, first along the southern fringes of the Nefūd and then by way of the old Pilgrim Route to Iraq. The appendixes, besides detailed discussions of various matters relating to the medieval history of certain places in Nejd and along the Pilgrim Route, include detailed narratives of the history of two families of Ibn Sa'ūd and Ibn Rashīd who have ruled over central Arabia since the eighteenth century. There is also a critical refutation of arguments that have been adduced tending to prove that Arabia has been the scene of progressive desiccation since antiquity.

Medals and Medalists. Under this title there has been published a booklet on the four medals awarded by the Society for distinguished work in exploration and geographical science. It contains a brief description of the Society's activities and publications, a statement of the founding and conditions of award of each medal together with a list of recipients to date, and a group of selected presentation addresses by officers of the Society and by diplomatic representatives of the United States who have acted on behalf of the Society. It is illustrated with photographs of the obverse and reverse sides of each medal. "Medals and Medalists" will be sent to any Fellow of the Society on request.

Distribution of Title Page, Contents, and Index of Volume 18 of the Geographical Review. The title page, table of contents, and index for Volume 18 of the *Geographical Review* (1928), which is issued separately, is ready for distribution. Copies are sent to all institutions exchanging publications with the Society and to individuals who request that their names be put on a list for this purpose.

GEOGRAPHICAL RECORD

NORTH AMERICA

Waddington Mountain, the Highest Peak in British Columbia. In the April, 1928, number of the *Geographical Review* there appeared an article on "Mystery Mountain," the name tentatively applied to a lofty peak of the Coast Range of British Columbia explored by the author, Mr. W. A. Don Munday, and his party. The name "Mt. George Dawson" was also proposed. The final decision of the Geographic Board of Canada, reached on April 3, 1928, makes the name "Waddington Mountain." The mountain has been definitely located and its elevation measured by a survey party working under the direction of the Survey Branch, Department of Lands of British Columbia. The triangulation survey was completed on September 10, 1927. It gives the geographical position of the mountain as latitude 51° 22′ 32″ North, longitude 125° 15′ 34.5″ West; the elevation as 13,260 feet above mean sea level.

This is the highest mountain in British Columbia, as far as known today, with the exception of Mt. Fairweather (15,287 feet) on the boundary between the Province and Alaska and only partly in British Columbia. There is little possibility that any other height will be found in British Columbia surpassing that of Waddington Mountain, yet its existence remained unnoticed until recent years.

The mountain is named for Alfred Waddington, one of the most enterprising of the pioneers of the Province. He went from England to the gold fields of California in 1849 and thence in 1858, when gold was discovered in the Fraser River area, to British Columbia. When the richness of the Cariboo gold fields was established he conceived the idea of constructing a wagon road from the head of Bute Inlet up the Homathko River to Fort Alexandria and thence to the Cariboo mines. In the prosecution of this idea he spent almost his entire fortune and, in spite of great difficulties, carried forward construction of the road until April, 1864. At that time certain Chilcotin Indians murdered nearly the whole personnel of his camp of road makers and destroyed his stock of tools and provisions, defeating his plan.

Waddington was among the first to urge the construction of an all-Canada railway from eastern Canada to the Pacific, submitting a possible western route. He died in Ottawa in 1872, just a few years before the construction of the Canadian Pacific Railway which made a reality of the project he had urged.

George G. Aitken

New Hampshire Mountain Rainfall. That mountains have heavier rainfall than the lowlands at their foot is a well known fact, though actual measurements of mountain rainfall are few and far between. Ahlmann obtained some valuable records on the Norwegian *fjells* which he used in preparation of a new rainfall map of the Scandinavian Peninsula (see review by Professor Jefferson, *Geogr. Rev.*, Vol. 16, 1926, pp. 494 and 495–497). The measurements obtained on top of Mt. Washington over a period of seventeen years, showing an average rainfall double that at the base, are repeatedly instanced. Now, forty years since the Mt. Washington observations closed, a new series of mountain rainfall observations in New England has been initiated. It is a response to the floods of November, 1927, when our meager knowledge of the rainfall factor was forcibly brought home (J. W. Goldthwait: The Gathering of Floods in the Connecticut River System, *Geogr. Rev.*, Vol. 18, 1928, pp. 428–445).

In "Summer Rainfall on New Hampshire Mountains" (*New Hampshire Highways*, Vol. 6, No. 6, September, 1928), Professor J. W. Goldthwait has summarized the results of the first available records. During July and August, 1928, rainfall figures were received from eighty stations in New Hampshire, mostly conducted by volunteer observers, where there had previously been only a dozen. Many were located in the mountains and others in adjacent valleys, offering lowland contrasts. Gorham, near the base of Mt. Washington at 800 feet elevation, had 5.32 inches of rainfall; Halfway House had 12.24 inches; and at the top, 6270 feet, 15.26 inches of rain were registered. Two stations, Madison Hut and Lake of the Clouds, which showed apparently deficient rainfall in proportion to their altitudes, are located in sheltered positions. Monadnock had 19.21 inches; Keene, 2600 feet lower, had 11.89 inches; and so for other pairs of mountain and lowland stations.

Since the heaviest rainfall of New Hampshire occurs in summer as a result of local thunderstorms, its quantity and distribution vary greatly within the state and from year to year. From selected cases which seem to be representative it can, however, be stated that the "mountain tops show from one and a half to two times as much rainfall during July–August 1928, as the valleys." Publication of the records for the remainder of the 1928 season will be awaited with interest.

Specialized Farming in Massachusetts. The Massachusetts farmer, no longer able to raise all he needs at home, is being forced either to leave the farm or to produce cash crops for local markets. In order to compete with the more fertile land farther west, the products of which have been made available by improved transportation, he must specialize in products too perishable or too bulky for long distance shipment. A study of data for towns derived from the United States Census of Agriculture taken in 1925 has enabled Ronald L. Mighell and Marian Brown to distinguish thirteen areas in Massachusetts in which different types of specialized farming have been developed (Type-of-Farming Areas in Massachusetts, *Mass. Agric. Exper. Sta. Bull. No. 244*, June, 1928). This publication is illustrated by a hypsometric map of the state and by dot maps showing farm population, number of farms, value of land and buildings, crops, and distribution of farm animals. These maps give a more detailed representation of the distribution of agricultural activities in Massachusetts than it would be possible to compile from the published report of the United States Census of Agriculture, since the smallest territorial unit for which statistics are given in the latter is the county. The statistics which made possible the construction of the maps were specially tabulated by the Census Bureau for the Massachusetts Department of Agriculture but have not been published.

Near Boston, Springfield, Fall River, and New Bedford, areas of specialized market gardening and poultry and egg farming have developed. Beyond these and extending into the hillier country are dairy districts. Rougher land is used for orchards, and in the mountainous regions woodlands and pasture predominate. Cranberry production is directly related to the occurrence of bog land in Plymouth and Barnstable counties, and tobacco culture to the fertile soil of the Connecticut Valley.

SOUTH AMERICA

The Bolivia-Paraguay Boundary Dispute. The Buenos Aires conferences on the Bolivia-Paraguay boundary dispute in the Chaco region which were convened as the result of an agreement signed at the Bolivian Legation at Buenos Aires on April 22, 1927, were closed by joint consent in July, 1928. At the final session it was decided to attempt again to settle the dispute by direct negotiations between the Foreign Offices of the two governments and, in case that failed to resort to arbitration. Subsequent incidents indicate the futility of attempting settlement by the former method; and as regards the latter there is disagreement both as to the arbitrator and as to what is to be arbitrated. Paraguay wants a *status quo* of present occupancy established on which future negotiations are to be based. Bolivia bases all her claims on the status of the common boundary between the colonial administrative divisions which became the independent republics of Bolivia and Paraguay after the overthrow of Spain. This status, technically known as the *uti possidetis* of 1810, has been the basis and the stumblingblock of all the major boundary disputes in Latin America. In no instance have the royal decrees which established the administrative divisions of the colonial system been so clearly stated as to permit of only one interpretation. Bolivia bases her claim to the whole of the Chaco region west of the Paraguay River and mouth of the Pilcomayo on a series of royal decrees of the sixteenth century in which, it is claimed, the Audiencia of Charcas, from which the Republic of Bolivia was created, was established and later extended to cover the area of the Bolivian claims. Paraguay claims that, when the Audiencia of Charcas was divided into two provinces in the early part of the seventeenth century, the new province included the whole basin of the Paraguay River and that, of the three districts into which it was divided, the district of Paraguay (from which the Republic of Paraguay was finally created) included not only the area east of the Paraguay River to which Bolivia would confine Paraguay but the whole basin of the river north of the Pilcomayo.

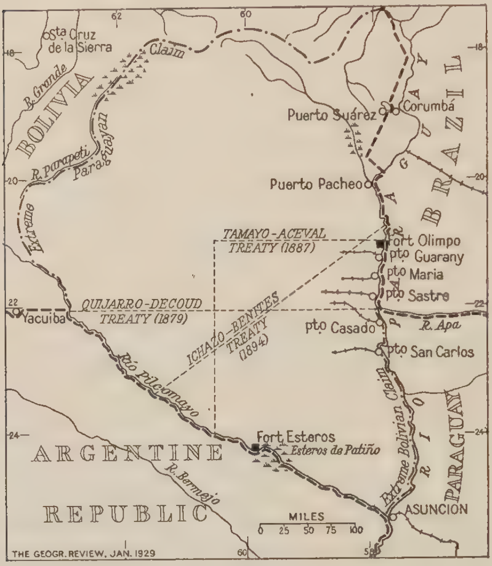

FIG. 1—Map illustrating the course of the Bolivia-Paraguay boundary dispute. Scale 1:13,000,000.

It was not until 1877, after Bolivia had lost her provinces on the Pacific, that she approached Paraguay for a boundary treaty, her chief object being to secure a river port on the Paraguay or the Pilcomayo that would give her access to the Atlantic. When President Hayes in 1876 arbitrated the Paraguay-Argentine dispute and established their boundary in the Chaco along the Pilcomayo River, Bolivia made no claim to any interest in the transaction. The various boundaries fixed by successive treaties, of 1879, 1887, and 1894, none of which were ratified, are shown on the accompanying map. Negotiations were again resumed in 1907, and the Pinilla-Soler protocol was signed which established a tentative boundary but in such vague terms that it has only led to further difficulties. An agreement of 1913 nullified all previous negotiations, but Paraguay still holds to the line of the Pinilla-Soler protocol of 1907 as the frontier.

As to the actual settlement and development of the Chaco region, it appears that Paraguay has made the more consistent and permanent efforts. Bolivia has established military outposts on the Pilcomayo River as far as the Esteros de Patiño and on the upper Paraguay maintains a wireless station at Puerto Suárez and has effectively occupied the territory from there westward to Santa Cruz de la Sierra. The Bolivian Government has fostered many colonization projects in the Chaco and made large grants of land to local and foreign development companies, but none have resulted in permanent settlement. Paraguay, on the other hand, has been steadily pushing out into the Chaco for many years. Fort Olimpo on the Paraguay River was established in 1792 and has always been held by Paraguayan troops.

After the failure of the Bolivian National Convention to ratify the Quijarro-Decoud Treaty of 1879, Paraguay began to settle colonists as far north as the 21st parallel. When Bolivia again failed to ratify the Tamayo-Aceval Treaty of 1887, Paraguay moved her outposts as far north as Puerto Pacheco and has remained in possession there since that time. Paraguayan and foreign interests have been granted concessions at many points west of the river south of Fort Olimpo for quebracho lumbering and cattle raising, and a number of roads and short railway lines have been built from ports on the Paraguay River to these concessions. The latest attempt at colonization by Paraguay on a large scale is the concession granted to Canadian Mennonites, which extends beyond the line of the Ichazo-Benites Treaty of 1894 (see John W. White: The Great Mennonite Migration to Paraguay, *Bull. Pan Amer. Union*, Vol. 61, 1927, pp. 432–442).

The Bolivian Government, meanwhile, has recently declared its intention to devote its efforts toward agricultural development to those areas on the highlands and in the upper valleys of the eastern slopes of the Andes that are now under cultivation, postponing all efforts toward the colonization of the Chaco to some future time when areas now under cultivation have reached their maximum productivity and the increase in population demands new lands.

Reconnaissance Map of the Pichis-Pachitea River System. Attention is called to the reconnaissance map of the Pichis-Pachitea rivers, Peru, made by Messrs J. T. Singewald and E. C. Roschen in 1925 and published on a scale of approximately 1:480,000 in the June, 1928, number of the *Bulletin of the Geological Society of America.* The Brunton compass was used for direction, and distance along the river bank was estimated; the traverse was tied to astronomically determined points at Masisea, Puerto Victoria, Puerto Bermudez, and two other stations. The Pachitea, with its tributary the Pichis, offers certain advantages as a route from the montaña to the Amazon. The course is free from the dangerous canyons, cataracts, and whirlpools that characterize the Marañon and Huallaga rivers and is also safer and more direct than that along the Perene. The chief drawback is the interruption of navigation during the period of low water. During high water there is steamer connection from Masisea, the terminus of the Iquitos steamers, on the Ucayali just below the confluence of the Pachitea and Puerto Bermudez. Farther up stream there is canoe connection with Puerto Yessup where the trail from La Merced ends. It is a link in the main route from Lima to Iquitos (compare Mr. Miller's article "The 1927–1928 Peruvian Expedition of the American Geographical Society," elsewhere in this *Review*) and is much traveled.

Mr. Singewald's expedition was primarily geological; the map is used to show the geology, and the accompanying article deals mainly with the stratigraphical succession. An interesting conclusion is hinted at: that the folding of the eastern Andes in this region is even more recent than had been supposed, late Tertiary instead of mid-Tertiary; but definite assertion awaits confirmatory evidence.

El Tronador and a South American Switzerland. No one has as yet climbed the summit of El Tronador (11,350 feet), that "superb volcano" on the Chilean-Argentine boundary. Federico Reichert has made three attempts to do so, but in each case an insurmountable obstacle blocked the goal. These attempts are recorded in his article "El Macizo del Tronador" in the new Argentine geographical magazine (*Gaea: Anales Soc. Argentina de Estudios Geogr.*, Vol. 2, 1927, pp. 385–402). Though failing in his avowed purpose, Reichert's efforts have served to renew interest in the Parque Nacional del Sur of Argentina, of which Tronador is the most magnificent feature (El Parque Nacional del Sur, *Gaea*, Vol. 2, 1926, pp. 264–316).

The National Government Line has made Bariloche, on the south shore of Lake Nahuel Huapi, the center of the park, easily accessible from Puerto San Antonio on the Atlantic Ocean. Access from the Pacific is more difficult. The journey from Puerto Montt to Puerto Varas on Lake Llanquihue is made by rail. A boat trip across the lake is followed by an automobile trip to Petrohué on Lake Todos los Santos. After crossing the lake a difficult trip by automobile, on horseback, and by boat leads through the pass of Pérez Rosales on the northern side of Tronador to Puerto Blest at the west end of Lake Nahuel Huapi. The density of the forest growth, the rugged topography, and the long detours necessary to avoid crossing the arms of Lakes Nahuel Huapi and Todos los Santos will prevent the construction of an all-rail route using the pass of Pérez Rosales, which otherwise offers the advantage of freedom from the heavy snows that occasionally block traffic on the Transandine Railway. The establishment of the long-contemplated Chilean National Park adjoining the Parque Nacional del Sur would increase the attractions of the region for tourists and emphasize the need of better transportation.

The panorama viewed from the east side of Tronador suggested to Reichert a simpler route by the Pass of Vuriloche to the south of Tronador. This route he identifies with the famous "lost road" of Vuriloche of the early Spanish days in Chile. If Reichert's view is substantiated it should offer a favorable transandean railway crossing. The distance to the Estero Reloncaví, the eastern arm of the gulf of that name, is short; and the arm is navigable for ocean steamers, furnishing an easy route to Puerto Montt, the terminus of the Longitudinal Railroad of Chile (see Fig. 2, p. 65 of this *Review*).

Argentine railroads extend like fingers towards the Chilean boundary. Chile has contemplated similar development. The railroad extending east from Concepción reaches within forty miles of the Argentine boundary; that leading east from Temuco is less nearly complete. Though a route from Valdivia across the Andes has been surveyed, the expense of construction will probably prevent it from being undertaken. Chile's present unfavorable financial situation, due to the competition between natural and manufactured nitrates, will at best delay the completion of these railroads. The route through the Pass of Vuriloche is, however, in a somewhat different class: it may attract foreign capital interested in the promising tourist trade of this "Switzerland of the Andes."

EUROPE

Some Recent Field Studies of Highland Peoples in Europe. In the *Sociological Review* for October, 1927, Dr. Johann Sölch of the University of Innsbruck deals with the historical and human geography of the Brenner Pass and its immediate vicinity. In the same journal for January, 1928, Professor W. Stanley Lewis and Mr. D. T. Williams present a clear descriptive summary of the observations of a group of British sociological students from Leplay House, London, made in the upper Adour Valley of the French Pyrenees in August, 1926. The competence shown by the authors of this paper in interpreting the geographical environment and its relations to the life of the local population reveals a significant trend in contemporary sociological research.

Patterns of village settlement in the Trentino are analyzed and correlated with the topography and rock structure by Professor Ezio Mosna (La conformazione del suolo e la distribuzione dei centri abitati nel Trentino, *Studi Trentini*, Classe II, Scienze Naturali ed Economiche, Vol. 8, 1927, Nos. 1 and 2). The settlements are grouped according to their location upon such features as valley floors, basins, gentle and steep slopes, mountain spurs, alluvial cones and other detrital slopes, alluvial and rock terraces, *roches moutonnées*, and "saddles."

The common phenomenon of the emigration of highland people is analyzed in several papers. Auguste Vautier eloquently describes the situation in the Ticino, or Italian-speaking canton of Switzerland (*Bull. Soc. Neuchâteloise de Géogr.*, Vol. 36, 1927, pp. 30–38). Here rugged mountain ridges separate narrow, steep-sided valleys, down which course wild streams. The traveler who strolls through the streets of the densely built villages finds many a deserted dwelling, with its gaping windows and crumbling walls. From some villages people have gone to the United States, from others to the Argentine or to France or even to Holland. Where spring freshets each year wash away more and more of the arable land and cover the lean fields with gravel, boulders, and clay; where avalanches and landslides are an almost constant menace to man and beast, the farmer finds little incentive to remain when more favored regions beckon him. Vautier believes that "the war which Holland wages against the sea should be waged by Ticino against its mountains." Nature, however, is not the only enemy. The land is divided into excessively small holdings, and there are often almost insuperable legal difficulties in the way of consolidating these into larger parcels better adapted to efficient farming methods. In order to acquire a small garden one purchaser "had to treat with twenty-eight proprietors." Nor does the tourist industry offer the resources it used to in the older, more leisurely days when summer visitors would linger among these valleys. Now tourist-laden automobiles rush through the villages without stopping, and railway passengers seldom leave the station platforms.

The Aude, Ariège, and Tet valleys of the eastern Pyrenees were studied by a group of sociologists from Leplay House in August, 1927. Conditions here are interpreted in a suggestive paper edited by Dr. Arthur Geddes in the *Sociological Review* for April, 1928. Population has been rapidly falling off during the last thirty years. In some localities it is less than half of what it was in the middle of the nineteenth century. "At first the decrease seems to have been directly due to emigration; now it is also due to the diminished size of families among those few who stay. The root cause of the present changes is the demand for labor and the offer of a livelihood with short hours and lighter work in industry, commerce, etc., in town, and of better, easier farming in the plains." The school system and conscription are also, in Dr. Geddes' opinion, contributory causes, in that they create among the younger men discontent with the surroundings of their childhood.

Slovakia is divided into a mountainous woodland zone to the north and a rich agricultural belt on the Danubian plains to the south. Although much the poorer in resources, the northern zone has the denser population. The farming land is here scattered in isolated patches and is not sufficient to support the people. This circumstance, together with the long annual respite from agricultural labor enforced by the severity of the winters, has favored the development of a great variety of petty local manufacturing industries, such as wood working, glass making, paper manufacturing, hemp weaving, and pottery work for the men, and hemp spinning, lace making, and embroidery for the women.

The Slovak peddler of small wares, iron wire, glass, cloth, poppy seed oil, wooden objects of various sorts, laces, etc. is a familiar sight throughout the Danubian countries. Before the World War Slovak highlanders also furnished farm labor in the Hungarian plains during the harvest season, which occurs there two months earlier than in the mountains. The new frontier between Czechoslovakia and Hungary, however, by severing the plains from the mountain area, has almost wholly stopped this seasonal migration of farm labor. The Czechoslovak government is attempting to remedy the difficult situation thus created by finding employment for the Slovak laborer in the agricultural lands of Bohemia and Moravia. It is also hoped that the new agrarian law, breaking up the large estates in favor of the peasants, may bring some relief. In spite of these measures, the mountain zone of Slovakia continues to be an area of extensive emigration to the United States, to Canada, and to the mines of northern France. But this emigration, although not seasonal, as in former days, "is also not an emigration without hope of return. One meets in many of the mountain villages fine, well-cared-for houses built with the dollars of emigrants who have returned home rich, and in nearly every village of the valley of the Vah one finds people speaking the English of America" (Pierre Deffontaines: Petits métiers et petits nomades de Slovaquie, *Rev. de Géogr. Alpine*, Vol. 15, 1927, pp. 567–576).

Mention may here be made of another most unusual type of migration in southeastern Europe, that of the market gardeners of Bulgaria briefly described in the *London Times* (weekly edit., August 16, 1928, p. 178). They come from an area of some 30 miles square about Trnovo, between the Balkan Range and the Danube, where the population is much too dense to be supported on local agriculture alone. For more than a century men of the region have wandered afield, mainly to adjacent countries but in some cases even as far as Belgium and France. In the latter part of last century it is estimated that the number of annual migrants amounted to 12,000. They go in companies of 12 to 15 persons, leaving in early March to return in the autumn. The peasants of this region have thus acquired "an unrivalled knowledge of the geography and economic conditions of Southeastern Europe and know where they can find a market for their produce and suitable land for growing it"; and furthermore they are "more intelligent and have a higher standard of life than anywhere else in Bulgaria."

AFRICA

Recent Developments in Ruanda-Urundi. Much geographical information about the little-known region, Ruanda-Urundi, is to be found in the 1924, 1925, and 1926 reports of the Belgian Government to the League of Nations on the Administration of these territories. The report for 1925 classifies the country on a climatic basis into five natural regions—long narrow belts running in a north-south direction. The first of these is the tropical lowland bordering Lake Tanganyika and the Ruzizi River with rainfall placed at an average of 850 millimeters; the second, directly to the east, consists of the high mountains forming the Congo-Nile watershed with rainfall twice as heavy or more so on the forested heights; the third is the central plateau which, with a temperate climate and rainfall average of 1200 meters, occupies most of the country. Still farther to the east lies the eastern depression, warmer with less rain, a part of the dry belt of eastern Africa. A fifth region may be distinguished in the volcanic district to the northwest where peculiar conditions of soil, fauna, and flora are recognized (the physiography of this district has been described by Hans Meyer in "Morphologie der Virungavulkane in Ruanda, Ostafrika," *Abhandl. Sächs. Akad. der Wiss., Leipzig, Math.-phys. Klasse*, Vol. 40, 1927, pp. 1–31). With the exception of this last district the seasons are well marked and everywhere the rainfall regimen is irregular both as to total precipitation and distribution.

The native population, on the latest estimates from 2,500,000 to 3,000,000 for Urundi and about 2,000,000 for Ruanda, is dominantly agricultural. Like most primitive agriculturists, however, the natives customarily plant only sufficient to last until the next harvest. Indeed, food is generally scarce for a month before the next crop is gathered. The efforts of the administration have been largely directed towards encouraging an agricultural surplus, partly as a basis for export and partly as a famine preventive. Manioc and sweet potatoes, two introduced crops, have not been very popular because they require a longer time to ripen than the bean—the great food staple—pea, and corn crops. They have, however, the great advantage of being more independent of seasonal conditions, as was well illustrated during the famine of 1925–1926 when deficiency of rain caused the failure of two successive harvests. Fortunately government efforts in the plains region had resulted in a surplus of manioc. The more mountainous areas, where the dissemination of ideas is greatly hindered by the poor means of communication, were badly hit. The apathetic population became demoralized, and strong efforts were necessary to force them to make provisions for the next harvest and to collect them at centers of food distribution. The chiefs, having failed to coöperate with government efforts to get manioc and sweet potatoes planted, a ruling by which, if such crops were not planted, the government in case of famine might appropriate enough of the chief's cattle to feed that chief's people was put into force with good effect. In 1926 there was a decided increase in all crops, including tobacco and coffee.

Ruanda-Urundi lies within the tsetse fly zone, both *Glossina palpalis*, associated with sleeping sickness in man, and *Glossina morsitans*, source of "nagana," cattle sickness, occurring (see I. W. Frantzen: Die geographische Verbreitung und wirtschaftgeographische Bedeutung der Tsetse-Fliege, *Materiaux pour l'Étude des Calamités*, January–March, 1928, Geneva). The infected zone stretches in a north-south belt from Lake Tanganyika east to the elevated lands of the Congo-Nile watershed. The lake plain has the most cases of sleeping sickness, because of the great number of marshes, the swampy banks of the rivers, and the banana groves—all favorite breeding places of the fly. Natives, fishing or traveling from one part of the lake to another, usually put in for the day at numerous inlets whence, after infection, they scatter to all parts of the Territory. The Mandatary Reports for 1925 and 1926 state that a general survey has been made of the whole country, the infected areas defined, and a program drawn up to combat the disease. This plan consists principally of grouping the natives in better locations along the routes of communication, of clearing and draining river and lake shores, of bridging fords, of razing banana groves and substituting other crops, and of regulating the movement of canoes and fishing on the lakes. A comparison between the maps published in the 1924 and 1926 Reports shows considerable diminution of the disease in the southern part. Less change was noted in the northern part, where the infection is not so prevalent.

Variations in and Possible Disappearance of Lake Chad. This is the title of a recent paper by Jean Tilho in the *Annales de Géographie* (Vol. 37, 1928, pp. 238–260). Lake Chad in the French Sudan spreads its waters over a nearly level plain. As a consequence, not only is the lake extremely shallow, but fluctuations in the surface level are accompanied by enormous changes in area. Detailed measurements of the levels were made at the post of Bol from October 20, 1912, to September 30, 1919. These showed annual variations in the surface of between .50 and 2 meters; low water occurs in July and high water in December. Besides the seasonal oscillations there are larger fluctuations occurring over periods of several years. During the low-water stages, known as "Little Chad," the lake becomes "an immense swamp with scattered mirrors of open water surrounded by forests of ambash (*Herminera elaphroxylon*)." All the northern part becomes "dry, and the inhabitants of the eastern archipelago, now joined to the coast, migrate toward the interior of the lake in search of green pastures and drinkable water, for the water of the many *bahrs* becomes dangerous to man and beast, owing to the concentration of the salts in solution. The coast of Kanem is joined to that of Bornu by the almost complete emergence of a broad threshold, to the north of which remain only vast ponds whose shores are covered by putrefying fish that send out an intolerable stench." During the high-water stage, or "Great Chad," "the lake regains its normal aspect with great expanses of open water."

Historical records throwing light on the dates of the periods of "Great Chad" and "Little Chad" are extremely scanty. Tilho, however, believes that there is sufficient evidence to warrant belief in a correlation between the advances and retreats of the Alpine glaciers and the variations in the lake levels.

Taking into consideration climatological factors alone, Tilho holds that there need be little fear that Lake Chad will dry up in the near future. A marked depletion of the supplies of water reaching the lake, however, has been brought about through the capture of one of the tributaries of the Logone, which flows into Chad, by the headward erosion of a branch of the Benue. There also seems to be imminent danger that the entire Logone may be deflected into the Benue. This would prove an extremely serious disaster. It would lead to the raising of the annual flood level of the Benue from 1.50 to 2 meters, and also, by depriving Lake Chad of one of its major tributaries, it would hasten the complete disappearance of the lake by evaporation. There seems little question that the lands in the vicinity of Chad are unusually fertile and that their potential value would be gravely impaired by the disappearance of the lake or further diminution of its area. Tilho recommends the construction of a great dam at a critical point in the channel leading from the Logone to the Benue. Such a dam would not only postpone indefinitely the danger of the desiccation of Lake Chad through the capture of the Logone, but would also put a stop to the present annual escape of the flood waters of the Logone into the Benue. "Chad would cease progressively to shrink, assuming again the aspect of a little inland sea with indefinite banks, the aspect which it presented when Denham, Barth, and Nachtigal saw it in the last century."

POLAR REGIONS

Some Recent Spitsbergen Studies. The characteristic of Spitsbergen as a "climatic outpost" is well exhibited in the vegetation map by V. S. Summerhayes and C. S. Elton accompanying their paper "Further Contributions to the Ecology of Spitsbergen" in the August, 1928, number of the *Journal of Ecology.* The meeting of the polar ice pack from the east with the Gulf Stream drift from the west produces a climatic gradient which is reflected in the life of the archipelago. Four vegetational zones are recognized; and, while the animal life is very impoverished as a result of isolation, there is a related distribution among land animals and the intertidal fauna; hence these zones can properly be described as life zones. On a broader scale the zones can be traced across Greenland and Arctic Canada and in the mountains of northern Scandinavia.

The vegetation of Northeast Land falls almost entirely in the Barren Zone. The ice-free ground is covered with rocky débris. "In some places, as at Murchison Bay, it is possible to walk for miles over the frost-shattered surface without seeing more than an occasional tuft of poppies." In the most favorable spots is an open growth of Arctic willow. Conditions are better in West Spitsbergen. In the exterior coastal regions, subject to sea fog, the mountain avens (*Dryas octopetala*) is a dominant form. Passing up the fiords, where the fog does not penetrate and where the temperature gradient is further heightened by the prevalence of föhn winds off the glaciers, the vegetation is richer. Heaths of the white arctic bell heather (*Cassiope tetragona*) occur characteristically. With further penetration we reach the fourth zone of most varied vegetation with species not found elsewhere in the islands. Thus, while Spitsbergen is beyond the tree, or even the scrub, limit, the dwarf birch is found in Coles Bay, Ice Fiord.

This paper by Messrs. Summerhayes and Elton is based mainly on work of the Oxford University Expeditions to Spitsbergen in 1921, 1923, and 1924. The general purpose of these expeditions has been told by Mr. George Binney, organizer and secretary of the first and organizer and leader of the second and third expeditions, in "With Seaplane and Sledge in the Arctic" (London, n. d.). The volume is primarily a narrative account of the third expedition, whose labors were devoted for the most part to Northeast Land. The preface by W. J. Sollas gives an excellent brief résumé of the work accomplished. Eventually the scientific results of the 1923 and 1924 expeditions are to be published in collected form as was done with the first expedition, "Spitsbergen Papers," Volume 1 (1925). Meanwhile reference may be made to some of the other papers that have already appeared.

"The Geology of North-East Land (Spitsbergen)" by K. S. Sanford (*Quart. Journ. Geol. Soc. of London*, Vol. 82, 1926, pp. 615–655) is specially interesting in that the author traces here the outer margin of the great arc of Caledonian folding that runs from Great Britain through Norway and Spitsbergen and northern Greenland. He also outlines the tectonic movements of late Tertiary time in which Northeast Land was cut off from the main island and cleft from west to east by the great fiord of Wahlenberg Bay.

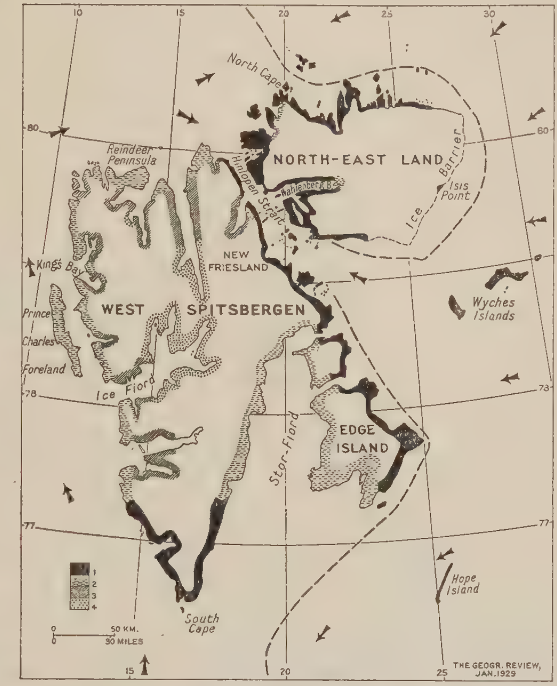

FIG. 1—Vegetation zones of the Spitsbergen archipelago, redrawn from the map by Summerhayes and Elton. The numbers have reference: 1, Barren zone; 2, Dryas zone; 3, Cassiope zone; 4, Inner Fiord zone. The areas left blank are mostly covered with permanent snow and ice. The broken line indicates the approximate limit of the ice pack in summer; the arrows show the direction of the ocean currents.

Minor forms of the landscape are dealt with by Mr. Elton in "The Nature and Origin of Soil-Polygons in Spitsbergen" (*ibid.*, Vol. 83, 1927, pp. 163–194). To the problem of this common phenomenon of Arctic and Alpine regions Mr. Elton makes helpful contribution by viewing it in three dimensions instead of the customary two (compare "Notes on Surface Markings in Spitsbergen," *Geogr. Rev.*, Vol. 14, 1924, pp. 486–487). He finds that an essential part is played by differential frost action in a vertical plane. The lower layers of the soil are wetter than those above; hence frost splitting is more intense on that level with production of more finely comminuted material. Frost action humps up mud from these lower layers, and the overlying stones are pushed aside. Disintegration of the stones continues, and the final stage may be a "mud-polygon." Mud polygons are well developed where frost action is particularly intense or rapid, as above Hinlopen Strait, where fogs around the pack ice are thick and temperatures low, or on Reindeer Peninsula, where the rock is a soft shaly sandstone. The polygons have a marked effect on the distribution of plant and animal life: while their slightly convex domes are bare, the borders are likely to support a thick mat of vegetation.

Northeast Land with an area of some 8000 square miles is largely covered by an ice dome rising to about 2300 feet and reaching the sea along a large part of the coast. Observations on the influence of this mass on the climate have been made by Mr. Sandford in "Summer in North-East Land, 1924: The Climate and Surface Changes" (*Geogr. Journ.*, Vol. 68, 1926, pp. 200–225). He concludes that: "There appears to be a type of 'intermittent glacial anticyclone,' which establishes itself, is blotted out by interference from outside the area, and quickly reëstablishes itself again.

Winds are most markedly outward-flowing, and lead to a definite augmentation of the bordering ice at the expense of the higher parts of the interior. There is some indication of a pulsation, from calm to blizzard. In summer the effect of this type of 'anticyclone' is very marked, and it is a factor of real importance in the control of the supply of the cap of ice."

In 1927 the Cambridge Expedition under the leadership of Mr. H. G. Watkins carried out investigations in Edge Island which, like the rest of eastern Spitsbergen, is less known than the west because of relative inaccessibility (H. G. Watkins: The Cambridge Expedition to Edge Island, *Geogr. Journ.*, Vol. 72, 1928, pp. 117–143). The only accurate mapping on the island was that of the Russo-Swedish Arc of Meridian Expedition of 1899–1901. While weather prevented the Cambridge Expedition from carrying out its complete program, some surveying was done on the southern coast and in the northwestern corner of the island. About one-third of the island is ice-covered in the form of domes rising to about 1500 feet arranged in a horseshoe shape around the center of the island, the ice reaching the sea on the south and east coasts. The ice cover seems to be diminishing; only at the highest point, above 2000 feet in the center of the island, does accumulation appear to be going on. Where the glaciers do not reach the sea they are in a state of retreat.

About fifty miles south-southeast of Edge Island is Hope Island, whose position and size have been shown more correctly on some of the ancient maps than on those of recent date. The island has now been mapped (1924) by Captain Thor Iversen in the course of his fisheries investigations in Spitsbergen waters on behalf of the Norwegian Government. The island, consisting of seven flat-topped hills sloping sharply to the shore, is 20 miles long and one-half to one mile wide. It is evidently a remnant of a larger land mass and is fast being reduced to a shoal by the attack of frost and surf—a process, however, that has been slowed down by recent elevation. Vegetation occurs in scattered places only, and the number of species is very small. The island has occasionally been used as a hunting station.

Captain Iversen's paper, which is entitled "Hopen (Hope Island)" forms Number 10 (1926) of Volume 1 of *Resultater av de Norske Statsunderstøttede Spitsbergenekspeditioner* (Oslo). This valuable series which publishes the results of the Norwegian state-supported Spitsbergen expeditions is being continued under the title of *Skrifter om Svalbard og Ishavet* (see below). Number 16 of the series "Déterminations Astronomiques" by Hans S. Jelstrup describes the determination of the astronomical position of Ankershamn, the wireless station at Green Harbor.

Scientific Exploration in Svalbard. The Norwegian Government has issued the following memorandum relating to the Organization of Survey Work and Scientific Exploration in Svalbard.

The Norwegian Government has established a central institution under the Ministry of Trade for the exploration of Svalbard and polar regions. This institution, the name of which is Norges Svalbard- og Ishavs-undersøkelser (Norwegian Scientific Exploration of Svalbard and the Arctic Sea), 34 Bygdø allé, Oslo, embraces, *inter alia*, all official survey and geological work and other natural-historical and geophysical exploration in Svalbard and also the survey of adjacent waters. This does not, however, include meteorological observations, which remain under the Meteorological Institute in Oslo, or special fisheries research, which is attached to the Fisheries Board at Bergen.

In order to achieve the best possible results in the scientific exploration of Svalbard it is essential that all expeditions intending to carry on such work in those islands give notification thereof to the Norwegian Ministry of Foreign Affairs and, in addition, send in particulars respecting the expedition to Norges Svalbard- og Ishavs-undersøkelser. These particulars should comprise a statement of plans—the scientific work to be undertaken, the territory to be covered, equipment, vessel, provisions, and personnel. The Norges Svalbard- og Ishavs-undersøkelser will then consider such plans. It will ascertain whether the work contemplated has already been done in whole or in part and whether there may be other expeditions already operating in the same tracts or contemplating so doing. This institution will, on request, supply information about literature and maps bearing upon the work contemplated, about scientific material in course of preparation, and the making of maps that may be of value to the expedition; it will also give practical hints relating to natural conditions and equipment. In addition, this institution will be able to give advice as to the particular Norwegian port at which the expedition should call for equipment control (see below) and furnish any other information required about sailings to Svalbard and of the possibility of procuring housing accommodation for the members of the expedition at the settlements in the islands. It is also the duty of the Norges Svalbard- og Ishavs-undersøkelser to give expeditions the necessary information relating to such Norwegian laws and regulations, e. g. close time provisions, as may be involved.

The services thus rendered by this institution are to be entirely free of charge, providing expeditions do not require reports involving a considerable amount of work or extra outlay. If, however, the institution is to fill its position efficiently as an inquiry office for Svalbard, the expeditions, on their part, must immediately on their return home submit a preliminary report on the work done and the results achieved. Further, they must send in two copies of all papers, books, and maps that may be published as a result of their work.

With a view to ending the chaos that has long prevailed in regard to geographical names in Svalbard, the Norwegian Government has initiated a comprehensive plan for the final determination of names for each locality. This work will be completed in about a year. To avoid further confusion in this direction each expedition desiring to give new geographical names must submit its proposals to the Norges Svalbard- og Ishavs-undersøkelser (foreign expeditions must send their proposals through the Norwegian Ministry of Foreign Affairs). This institution will consider such proposals and submit a recommendation. The final decision lies with the competent Norwegian authority.

Furthermore, attention is called to the fact that by Act of August 6, 1915 (see also Orders in Council of Dec. 15, 1917, Sept. 3, 1920, and Jan. 17, 1928) the equipment and provisioning of Norwegian expeditions to Arctic regions is subject to official control. This act primarily concerns hunting expeditions but applies also to expeditions fitted out at Norwegian ports for purposes other than hunting when they state, or there is cause to believe, that they intend to spend part or the whole of the winter in those regions. It moreover embraces expeditions made under such conditions as may necessitate wintering even though this may not be intended. Then again, the provisions of this act are applicable to foreign expeditions engaging as members Norwegian subjects in Norwegian ports, when it is stated, or there is cause to believe, that such expeditions have the intention of wintering or are proceeding to such tracts or such conditions as may necessitate wintering.

Notification of expeditions must be made to the *Politimester* (Superintendent of Police) at the port where they are fitted out; but in respect of foreign expeditions such notification may be given through Norges Svalbard- og Ishavs-undersøkelser, in which event the Norwegian port from which the expedition intends to sail must be stated. Control is exercised by a committee comprising a government ship surveyor and a second member with experience of wintering conditions in Arctic regions; the latter shall be nominated by the president of the court.

It has been found necessary to exercise such a control as this act establishes, for it happens not infrequently that expeditions and persons proceeding to Svalbard are so poorly equipped that they get into difficulties. If such an expedition is in distress some of its members may reach one of the settlements where there is a telegraph office and report that the remaining members are in peril and require immediate help. Should some time elapse without any news coming in about an expedition, demands for a search will very soon be heard. In such instances the Norwegian Government has had to send out or cause to be sent out relief expeditions. Also out of consideration for the coal-mining companies in Svalbard the control of touring, hunting, and scientific expeditions is a necessity. It has happened that expeditions have arrived at Svalbard so poorly fitted out that they have become a burden to the neighboring mining community from the first, and it is not always an easy matter for the mining companies to afford adequate help. In the summer months it does not matter so much, but it is a serious problem for these companies when members of some expedition or other that is in a helpless plight suddenly appear in midwinter and have to be furnished with shelter, food, and medical aid, or may perhaps require a relief attempt.

As has already been mentioned, meteorological work in Svalbard is in the charge of the Norwegian Meteorological Institute. The Norwegian Government has established two meteorological stations in Svalbard, one being at Tunheim on Bear Island and the other at Ankershamn, Green Harbor. The Norwegian Meteorological Institute will, on request, give scientific expeditions wishing to work in Svalbard all necessary information respecting climatic conditions and the meteorological work done there.

It may also be pointed out that Norges Svalbard- og Ishavs-undersøkelser publishes *Skrifter om Svalbard og Ishavet* giving an account of all scientific results published in Norway from those regions. Foreigners will also be given the opportunity of having their papers printed in this publication series, on condition that they defray the cost of printing.

PHYSICAL GEOGRAPHY

Physical Characteristics of Sea Ice and River Ice. Dr. Finn Malmgren's work "On the Properties of Sea-Ice," published as Volume I, Number 5, of the Scientific Results of the Norwegian North Polar Expedition with the "Maud" 1918–1925 (Bergen, 1927), contributes basic data in a still imperfectly known field. While a purely physical exposition, the work has its geographical bearings, for sea ice plays an important if not fully comprehended rôle in the general circulation of the globe, as the veteran investigator, Dr. Otto Pettersson, shows in his paper elsewhere in this number of the *Geographical Review.*

The way in which salt exists in ice is of fundamental importance. In water salt is present in homogeneous solution, in ice it is found as a concentrated brine in cavities of the pure ice and at low temperatures as small crystals all through the ice. The condition is unstable; during the summer time when melting takes place, the brine moves downwards; the phenomenon of fresh-water pools on the surface of old ice is well known. The state in which the salt is held in the ice leads to abnormalities in its physical properties. The peculiarities of the latent heat of fusion and the heat expansion of sea ice, first investigated by Otto Pettersson, were followed up by Dr. Malmgren, and new work was done on other physical constants: the first determination of the specific heat of sea ice was made, and the first precise observations on the specific gravity of sea ice in the interior of the Arctic Sea were taken.

Records were obtained of the temperatures of sea ice, and comparison was made with Nansen's findings on the *Fram.* The temperature data were used for calculation of the thermal conductivity of sea ice with very important conclusions. During the period September to April, heat is conveyed to the atmosphere above the Arctic Sea in such quantity as to raise the lower layer—some 150 meters thick—an average of 6.9° C. This amount of heat "greatly contributes to diminish the cold of winter and explains the fact that, despite the clear winter sky and the calm weather, we have over the Polar Sea considerably milder winter temperatures than further south over the continent of Asia."

Parenthetically reference may here be made to the appreciations of Dr. Malmgren's life and works by Axel Wallén and H. U. Sverdrup in *Ymer*, Vol. 48, 1928, pp. 243–245 and 246–252 respectively.

From theoretical considerations we turn to a question of immediate practical interest in Howard T. Barnes's new work, "Ice Engineering" (Montreal, 1928), dealing mainly with river ice. Since his earlier work, "Ice Formation" (1906) was published, Dr. Barnes has continued the study of the physical behavior of fresh water ice in relation to methods of ice control with good results. Features upon which he lays particular stress are the significance of small temperature differences in ice formation and the importance of ice prevention. In the chapter on "Ice Navigation and Ice Breaking" he gives many instances of the success attained. Thus, since 1908 ice breakers have succeeded in clearing out the great ice jam that forms at Cap Rouge just above Quebec and have thus kept the river open to Three Rivers and have prevented the former winter flooding of riverine farms between Lake St. Peter and Quebec. The chapter on "Ice Remedial Work" discusses such methods of control as flood lighting, which simulates the disintegrating action of sunlight, and his own experiments with thermit for destroying ice jams and icebergs (compare the note "Recent Work on Iceberg Drift and Control in the North Atlantic," *Geogr. Rev.*, Vol. 17, 1927, pp. 678–679). As Dr. Barnes aptly observes, "In northern countries an ice engineer is as essential as a highway engineer."

The Influence of Forests on Rainfall and Run-off. While the definite solution of the problem of the influence of forests on rainfall and floods is still to be solved the matter is of perennial interest. Raphael Zon's paper "Forests and Water in the Light of Scientific Investigation" originally published as an appendix to the "Final Report of the National Waterways Commission, 1912" was reprinted by the Forest Service in 1927. The text is unchanged; but the bibliography, a very valuable feature, has been brought up to date. "Forests and Floods," by Ward Shepard (*U. S. Dept. of Agric. Circular No. 19*, 1928), inspired largely by the Mississippi floods, presents many striking examples of devastation wrought on denuded woodlands, overgrazed hillsides, and eroded farms but brings no new light to bear on the problem. A new approach, however, is offered by Dr. C. E. P. Brooks in a useful contribution made under the above title to the January, 1928, number of the *Quarterly Journal of the Meteorological Society*. Dr. Brooks has made a critical analysis of various statistical investigations into the problem and has arrived at certain conclusions therefrom. His conclusions are:

1. The replacement of forests by field crops or grassland probably tends to increase the general rainfall of the district slightly; their replacement by bare ground probably tends to decrease the general rainfall slightly.
2. Forests increase the local rainfall by one to two per cent, this effect being due to the increase in the effective level of the ground by the height of the trees and by the greater friction of the wind with the tree surface compared with open ground.
3. To this may be added, in favorable mountain situations, an increased supply of water collected mechanically from clouds which envelop the forests.
4. Afforestation of grass or crop land probably increases the local run-off by ten to twenty per cent, this amount being made up partly by the decreased loss of water in evaporation and transpiration, partly in the slight increase of actual rainfall. This is likely to be the most noticeable effect of afforestation. Afforestation of bare ground would decrease the run-off, but this effect would be masked by the much greater regularity of the flow.
5. Forests, drawing their water supply from deep sources, possibly exercise a slight mitigating effect on droughts.

GEOGRAPHICAL NEWS

The Angrand Prize Award to Koch-Grünberg. The international Angrand prize for studies in the Americanist field, the distribution of which is in the hands of the Bibliothèque Nationale, Paris, has for the present year been awarded to Theodor Koch-Grünberg, in memoriam. In making this award, French science has paid a tribute to a German who was of outstanding merit both as a scientist and as a man.

Koch-Grünberg was one of the many students who are to be numbered among the followers of Karl von den Steinen; perhaps he has achieved more than any other of them. He began his long series of South American field studies by taking part in Dr. Hermann Meyer's Xingu expedition in 1898–1900. During 1903–1905 he made his first independent journey of exploration, on which he carried out a thoroughgoing study of the Indian tribes occupying the banks of many of the tributaries of Rio Negro. The principal work resulting from that journey was "Zwei Jahre unter den Indianern" (Berlin, 1909–10), in which he presents a detailed study of the habits and customs of the Indians and especially their mask dances. It is an excellent travel narrative that should be made available in an English translation. In many treatises, large and small, he worked up the extensive linguistic material collected. In the years 1911–1913 Koch-Grünberg again undertook an important journey, during which he studied the Indian tribes located between Roraima and the Orinoco. The results of that expedition are embodied for the most part in his great work, "Von Roraima zum Orinoco," published in several parts, one of which has appeared since his death. It is for the last-mentioned part of that work that the prize has formally been awarded. It deals exhaustively with the culture and language of the Indians. In one part he gives a masterly account of the actual journey; and this, too, should be translated into English. The World War and the following economic depression prevented Koch-Grünberg, as it did many others, from continuing his journeys of exploration, a state of things that to him, with his love for active work, was very trying. During that period (1913 to 1924) he was Director of the Stuttgart Ethnographical Museum, admirably organized by him and now ranking among the best in Europe as regards its American collections.

In 1924 Koch-Grünberg received an offer to participate in the Orinoco expedition then planned by Dr. Hamilton Rice. However, as it turned out, he took part only in the first stages of that expedition. In October, 1924, he died on Rio Branco from malaria, and by his death American research suffered an irreparable loss.

Koch-Grünberg was no theorist. As far as I can find he never indulged in speculations about the age of man in America, about Graebner's "Kultuskreislehre," and such like. His outstanding achievement lies in his collection of a vast body of observations on the mental and material culture of the Indians and his publication of this material in an excellent manner. He possessed in high degree the power of acquiring the friendship and confidence of the Indians, who rewarded him by allowing him to obtain a deep insight into their inner life. To Koch-Grünberg the Indians were no mere objects of study; they were, above all, fellow beings, unfortunately and hopelessly involved in a struggle against so-called civilization.

In conclusion it should here be pointed out that, although first and foremost an ethnographer, Koch-Grünberg did not neglect geography; and there is no doubt that he has contributed very materially to the improvement of the maps of northwestern Brazil.

Erland Nordenskiöld

Obituary

Thomas Chrowder Chamberlin. Professor T. C. Chamberlin, long recognized as the dean of American geology and a commanding figure in science, died in Chicago, November 15, 1928, at the age of 85. Notice of his passing came shortly after announcement of his last book "The Two Solar Families," a revision of the well known work "The Origin of the Earth." Evidently the remarkable vigor and clear mentality that always characterized him remained to the end. It seems fitting that the last year of his life marked the rounding out of those studies in cosmogony and geology for which he is especially famous.

Only a year ago Professor Chamberlin appeared before the Geological Society of America at its annual meeting in Cleveland. For the second time within four years he was the recipient of a medal for outstanding contributions in geology. All who heard his address on that occasion were impressed with the remarkable preservation of his faculties. His enthusiasm and the breadth of his scientific outlook seemed unimpaired, and obviously the kindliness of his nature had not suffered with years. Before all else this aspect of the man deserves emphasis. His many students recall with gratitude and inspiration the simplicity and wholesomeness of his personality.

Chamberlin was born and reared in the Middle West, and most of his work was done in his native section. Few geologists have been more versatile. As head of the Geological Survey of Wisconsin he was confronted with problems of diverse character; and it was his habit not merely to do the task at hand, but to do it exceptionally well. Glacial geology engaged his early attention, and he was the first in America to find conclusive evidence of successive glacial stages in the Pleistocene. The mechanics of glacier motion and the cause of glacial climates are among the subjects to which he made valuable contributions. He also turned his attention to problems of sedimentary rocks and to the metalliferous deposits of Wisconsin. The merit of his discussion on lead and zinc is still recognized by economic geologists.

For more than twenty years Chamberlin was in charge of the glacial division of the U. S. Geological Survey, and during that time he contributed many important papers on subjects related to glacial geology. Other large tasks claimed much of his energy during the same period. For five years he was president of the University of Wisconsin. In 1892 he accepted the headship of the new department of geology in the University of Chicago, a position which he held until his retirement in 1919. *The Journal of Geology*, of which he was editor for 35 years, was founded in 1893. In collaboration with his colleague, R. D. Salisbury, he prepared the well known Chicago textbooks of geology.

Chamberlin's bibliography, arranged chronologically, reveals a fundamental change in his interest beginning in the year 1900. Up to that time he wrote chiefly on glacial geology and climatic changes; in 1900 the emphasis shifted to questions of earth origin. Obviously, he was led into the field of cosmogony largely through his study of the atmosphere. Several papers marked the evolution of his new ideas, and the three-volume "Geology," which appeared in 1904, gave large space to his planetesimal hypothesis. The breadth of his interest in geology always remained, but his later writings were devoted largely to development of the hypothesis and discussion of its geologic consequences. A series of articles on "Diastrophism and the Formative Processes" extended through a period of several years, and another series on "Fundamental Problems of Geology" ranges from 1904 to 1928 in the Yearbook of the Carnegie Institution. "The Origin of the Earth," which appeared in 1916, brought together the developments of the Chamberlin-Moulton hypothesis up to that time, and "The Two Solar Families" gives the final results of the long study.

Chamberlin's contributions to geologic thought have been extensive and profound. His greatest effort was in a speculative field, and appraisal of its ultimate value must await future developments. It is significant, however, that all prominent modern hypotheses on the evolution of the solar system have adopted Chamberlin's idea of biparental origin. This fundamental conception is his, and it has marked a new point of departure in studies of cosmogony.

Chester R. Longwell

GEOGRAPHICAL REVIEWS

SOUTH AMERICA IN THE "GÉOGRAPHIE UNIVERSELLE"

PIERRE DENIS. **Amérique du Sud.** Part I, 210 pp.; maps, diagr., ills., bibliogr.; Part II, pp. 211–479; maps, diagr., ills., bibliogr., index. (Géographie Universelle, Vol. 15). Librairie Armand Colin, Paris, 1927. 50 frs. for Part I, 70 frs. for Part II. 11½ x 8 inches.

A generation has passed since Elisée Reclus brought to a close the publication of his monumental "Géographie Universelle." The two volumes on South America concluded the series in 1894. When they were written, the era of the first scientific exploration of the continent by a series of remarkable naturalist travelers was complete. But since then other workers, more modern in their scientific equipment than were the original explorers, have been in the field, and the time has now come for a new "Universelle." It is a matter for satisfaction that the editors of the new work were able to secure M. Pierre Denis as the author of "Amérique du Sud." Since the nineties, geographical description has acquired a well recognized technique; and a wide public, both technical and general, had good reason to know from his excellent books on Brazil and on Argentina that Denis is a talented geographer and an excellent exponent of modern geographical writing who furthermore has the ability to say much in few words.

The first fifth of the work comprises four general chapters on South America, viz.: structure and relief; climate, including relation to vegetation; native population; colonization. Throughout the remainder of the work each chapter deals either with a natural region within limits based upon physical factors and upon the trend of colonization or with a political unit subdivided into its own natural regions.

While the main function of the author has been to present a regional geography of South America it must be recorded that in the process he has produced a valuable synopsis of the several physical aspects of the continent.

The aggregate amount of geological information that has been brought together in the book is large, and in general it is properly utilized in the text as a geographical element, being mainly directed to surface forms.

The land form descriptions are excellent and concise both in the opening chapter and throughout. While the evidences of erosion cycles are introduced into most of these, the author does not lose sight of the different significance of such traces in different climates. For example, in regard to Brazil where on the great central plateau the forms are clearly attributable to two or more cycles of normal erosion, in the southeastern coastal zone and again in the Guianas the processes peculiar to hot humid climates are invoked to account for the surface. There, owing to the profound chemical decomposition, running water hardly reaches the solid rock; and in such conditions the forms characteristic of stages in the normal cycle do not prevail. The morphological passages indeed contain many masterpieces of compilation and of compression; for example, that dealing with northeastern Brazil and its superimposed drainage system; that of Goyaz, a description pieced together from the work of several explorers; that of the Amazonian surface, represented as the result of depression succeeding elevation and dissection, so that the alluvial margin is likened to a ria coast; or of the Amazonian rivers, where the essential contrast between "white" and "black" rivers (*rios brancos* and *negros*) is explained. The Andean chapters also furnish many excellent examples. In writing of Ecuador, it may be noted, the author challenges Meyer's glacial origin of the high basin fillings, and argues in favor of excessive water deposit during the major volcanic period. In describing the llanos of Venezuela, again, he points out the danger of drawing conclusions as to the nature and origin of their deposits on the basis of the very local observations so far made.

The origin, amount, and incidence of rainfall are summarized in two interesting maps, on one of which notes are printed showing the months in which the main harvests, movements of stock, etc., take place. The reader, after having the salient features of each climatic type presented to him in a general way in this chapter, will have these essentials indelibly impressed upon his mind as he proceeds. It is not merely that many phenomena that have long been puzzling may well be explained to him for the first time; as, for instance, the *friaghem* of the central regions—abnormally cold and foggy spells with southerly winds in winter—or the distribution and uncertainty of rain in northeastern Brazil. It is rather because the author never omits to connect the vegetation with the climate and above all because the effect of the regimen upon man is constantly reiterated that this account of climate is well nigh unique. But of both these matters, more anon.

The colored map showing the nineteen major vegetation associations of the continent is new, clear, and valuable. The plant life is further given its proper place in every landscape described; its distribution is illustrated in many of the maps, and the author is at pains to explain it not only by reference to climate but to soil. Special attention is devoted to this in inner Brazil, where in a general way the northern limit of the sandstones of the Matto Grosso plateau coincides with the southern boundary of the continuous Amazonian forest with *javary* palm and the *castanheira*; and again about the head streams of the Paraguay there is surprisingly little forest, but tree growth is found to be specially favored on the basaltic ridge that extends parallel with and south of the scarp of the sandstone plateau. In the interesting marginal region of southern Brazil, while the main points are well selected to show the transition between tropical and temperate climates—the limits of orange, coffee, and sugar cane being noted—the effect of soil as determining the forest margins is also stressed. The Andean chapters contain very considerable data regarding the altitudinal and latitudinal ranges of associations and forms of agriculture.

Denis never fails to consider the time element. The seasonal rhythm appropriate to each region is outlined, and the annual pulsation of human life with its many variations is admirably emphasized. A serious student of this book should have no difficulty in discovering what is the particular employment of the average inhabitant of all the regions of the continent at any given month of the year. And he will have been taught to understand the reasons.

It is difficult to select passages regarding the human geography for special notice. But to take two very different regions, Colombia and northeastern Brazil. The Colombia chapter requires close reading, for this is a complex region. From its position and remarkable relief there results a great variation in climate. But so well is all this handled that the reader will reach a full understanding, for example, of a curious phenomenon, the complete reversal of the agricultural year within two degrees of latitude. This may be set down as follows:

Bogotá plateau	*Antioquia*
February: main sowing	September: main sowing
August: main harvest	January: main harvest
September: secondary sowing	March–April: secondary sowing
December: secondary harvest	August: secondary harvest

The evidence of the virility and energy of a section of the Colombian people will surprise many readers. The state of Antioquia, without immigration, more than quadrupled its population in the period 1808–1884. Moreover, the account of the vigorous campaign of forest clearance and colonization by which this population penetrated southward on the Central Cordillera during the mid-nineteenth century recalls the cutting of the way to the Pacific in the northern continent.

In the description of the Sertão of northeastern Brazil, where the cattle herding requires much exacting labor owing to the drought, cultivation is shown to be normally restricted to land of two types: the *rocados*, clearings in the bush enclosed against the cattle and sown at the onset of the rains, and the *vasantes*, consisting of low-lying damp ground. The way in which a departure from climatic means affects this district—as it does frequently—is explained. Thus, quite short periods of intense drought occurring during the *invierno* ruin the crops on the *rocados*, while excess of late season rains swamp the *vasantes*. The periodic exodus of population from this region after excessive drought has often been noted and also the splendid efforts for drought resistance by water storage and by building roads and railways which incidentally foster the cotton-growing industry of the Sertão.

The illustrations of these volumes of the "Universelle," both photographs, diagrams, and maps, are admirable. Only those who have made the search will know that the topographic maps that are given represent the cream of South American surveys, and will be aware of the general lack of such maps for most of the continent. But the point to stress here is that M. Denis has inserted these. The maps of all kinds and scales are clear, well drawn, and most helpful; many of them are, in part, original. But the fact remains that much of the work cannot be properly followed without constant reference to other maps. And unfortunately no atlas is really good enough. The sheets of the American Geographical Society's Millionth Map of Hispanic America, as far as these have been published to date, supply this need.

ALAN G. OGILVIE

THE IRRIGATION PROBLEM IN THE UNITED STATES

R. P. TEELE. **The Economics of Land Reclamation in the United States.** xv and 337 pp.; maps, diagrs., index. A. W. Shaw Co., Chicago and New York; A. W. Shaw & Co., Ltd., London, 1927. $4.00. 8½ x 6 inches.

This book on reclamation by the late Dr. Teele was written from a long experience in Federal Departments, and, as might be expected, it is a comprehensive and inclusive survey of the field. Specific attention will here be called to a few chapters of more particularly geographical interest, namely, Chapter II on the Place of Irrigation and Drainage in our National Economy, Chapter VII on the Rate of Utilization of Reclaimed Land, Chapter X on the Relations between Physical and Economic Conditions, and Chapter XI on Future Irrigation and Drainage Policies.

The tables and the accompanying text in Chapter II are source materials covering many phases of irrigation. Here in compact form are collected data of the extent of irrigated and drained lands, of the possible extent of irrigation, importance of crops under irrigation, and future needs for such enterprises. Crops grown under irrigation have to bear the expense of water rates and also, since a large market is generally distant from the arid lands, the long freightage. Competition therefore becomes a factor with the farmer of irrigated lands particularly if he seeks the same markets as the humid-area farmer. The question of subsidization arises and has to be worked out on the process of equalization so that injustice will not result to either the arid-land farmer or the humid-land farmer.

In Chapter VII the rates of utilization on a number of projects are graphically portrayed in order to show the lag between expenditures for irrigation and the use of the land. This lag is considered by many as the main reason for the seeming failure of irrigation from the financial standpoint. Only a few of the projects have the entire irrigable areas under cultivation; while the great bulk of them are not yielding an adequate return for the money expended.

The influence of climate on the success of reclamation enterprises is discussed in Chapter X. Where farmers can maintain their acres without irrigation even though irrigation will yield greater harvests, they appear unwilling to pay for water. Thus in the Great Plains sections, irrigation projects are less successful than in the more arid regions, and a number of irrigation plants in the Great Plains states have been abandoned.

The humid-zone farmer buys his acreage and works it on his own initiative. In arid zones where population presses the work must be coöperative. In the former the outlay is not large, but in the latter considerable capital is necessary at the outset. The Salt River project cost over $15,000,000, and there are 213,000 irrigable acres. From the standpoint of land alone the humid-zone farmer has an advantage. On the other hand, the yield per acre on irrigated lands is in excess of that on non-irrigated lands. Potatoes, for example, show an excess on value per acre of 34 per cent and wheat of 58 per cent. Thus the difference in initial costs is somewhat equalized. The balancing of all the cost factors of competing lands and crops with those of return from crops forms the best criterion for a subsidy. The author of the book, however, introduces many arguments that have been current for the subsidization of irrigation projects.

The whole problem is an intricate one. To one who desires to make an intensive study of the irrigation question this book is strongly recommended.

Robert M. Brown

Regional Geography of the Eastern Alps

Norbert Krebs. **Die Ostalpen und das Heutige Österreich: Eine Länderkunde.** 2nd edit. Vol. 1: Systematischer Teil, xiii and 330 pp.; maps, diagrs., ills., bibliogr.; Vol. 2: Regionaler Teil, x and 496 pp.; maps, diagrs., ills., bibliogr., indexes. J. Engelhorn, Stuttgart, 1928. 9 x 6 inches.

An enlarged, two volume edition of the 1913 "Länderkunde der Österreichischen Alpen," published by Dr. Norbert Krebs when privatdocent at Vienna. It is better than the earlier book, which was good. There are more pictures, more maps, and fuller material. The modifications in maps to fit the present political boundaries of the country are not important, but the enrichment of detail is.

On isostasy the earlier edition had a general statement as to what isostasy led us to expect in the eastern Alps. The present edition gives a map of points where gravity measurements show excess and where they show defect of mass, together with references. The central part of the region in general shows defect of mass, the margins excess. The regions are in fair equilibrium—a little overloaded. The lighter parts of the crust have been greatly thickened by folding, and these folds have sunk down, while they were forming, into the plastic basement so that the folds grew downward as well as upward, while in neighboring areas of depression the heavy parts of the undercrust that have flowed there lie nearer the surface.

The very interesting rainfall map is replaced by a new one by the Austrian Meteorological Service, more detailed; but we are not told for what period. The admirable map of population density which actually outlined the uninhabited mountain areas and showed the people limited, as they of course are, is replaced by a new one—for 1923. This is made on the dot method, which may be more graphic but prevents us from perceiving changes.

There is no political geography except a note of discontent with the new conditions, which include in Austria only 90,000 of the 117,000 square kilometers of German speech and 6½ of the 10 millions of German speakers.

Geology and geomorphology are the dominant notes, to which things economic are not very closely tied.

Mark Jefferson

REGIONAL POLITICAL ECONOMY OF CHINA

FRIEDRICH OTTE. **China: Wirtschaftspolitische Landeskunde.** vii and 111 pp.; map, diagrs., bibliogr. *Petermanns Mitt. Ergänzungsheft No. 194*, 1927.

Dr. Otte first served in the Chinese tax administration and, after the World War, was called to the Chair of Economics in the National University at Peking. He divides his book into three parts: A. China's government and finance; B. Production; C. Intercourse. Government and finance is disposed of in twenty-nine pages, but even that brevity permits the author to put together many well chosen facts, so that the chapter is distinctly serviceable to the uninformed.

Part B is devoted to "Production" under the headings, Farming, Forestry, Fishery, and Industry. The land-tenure systems are discussed, together with the influence of modern transportation by rail and ship, the development of Manchuria, and the importance of regions of excess production. The regional distribution of farm products is considered, but unfortunately without reference to the natural physiographic subdivisions of the land. The opium problem is discussed clearly and fairly in a short special chapter.

The chapter on forestry deals with the regional distribution of woods, with the thriftless deforestation of the land, and with the attempts which have been made, chiefly by foreigners, to restore woodlands and to teach their importance. Dr. Otte does not consider the changes of climate, which are probably partially responsible for the reduction of forests. The chapter on fishery includes an especially instructive analysis of the laws regulating the rights to fish in Chinese waters.

Dr. Otte offers a brief, honest analysis of the growing industrial enterprises in China. Rooted in the favorable combination of abundant raw material and a vast population whose capacity for skillful labor is unquestioned, and with large markets at home and abroad, China's industries should have grown faster than they have. English, Japanese, Germans, French, and Americans have aided and encouraged industry in China by means of teaching, organization, investment of capital, and even the invention of special machinery. Very slowly the Chinese have responded, hindered by their backward methods of financing, by the dullness which is miscalled conservatism, by the direct interference of the lawless civil wars, and by the disturbances among the masses which strikes and propaganda have developed. Nevertheless industries are multiplying and have an important future, especially with Chinese capital. A brief, excellent review of the distribution of industries shows that while some are advancing rapidly, like the vegetable-oil factories and the cotton-textile industries, others, such as the silk industry and the making of brick tea, have gone backward.

Old as the use of metals is in China, the Chinese are the last important people to adopt European methods of winning ore and smelting metals. The author discusses the mines of China, showing her wealth in excellent coals, her comparative poverty in iron, copper, silver, and lead, the importance of her tin and antimony, and the possibility of a modest future for her tungsten.

Part C, "Intercourse," includes chapters on roads and waterways, railroads, post, telegraphy and airplanes, trade, currency, and banking. Roads he dismisses, as every one must in considering the problems of China today, with a glance at their history and a word about the influence of the motor car. Probably no land of considerable size and wealth has received the motor car so grudgingly and responded to its introduction with so few good highways as China.

Harbors are subdivided conveniently, but artificially, into junk harbors and steamer harbors, delta harbors being mentioned as a class. The improvements which have been achieved, almost wholly by foreigners, have alone made possible the development of China's modern trade with the world. He considers harbor after harbor, noting the fundamental structure of each and the improvements that have been made. Tables of shipping are given, estimating the rank of the several seaports, as well as the total tonnage and number of ships of the chief trading nationalities.

He gives a brief review of the history of railroad building in China since 1876, when the first short road was built by the English in the hope that the Chinese would recognize the value of railroads: but the government tore up the road. Not until after the war with Japan was serious railroad building attempted. The period of concessions and "spheres of influence" between 1895 and 1911 witnesses the greatest advance in railroad building. Since then but few additions have been made. The subsequent history of the roads is mainly one of changing policies, controls, and indebtedness. I cannot follow Dr. Otte in his opinion that the reasons for China's failure to build railroads, especially in the south, are "chiefly geographical." The line connecting Canton with Changsha would not have to overcome as great topographic barriers as did the line from Peking to Paotow, which was built by Chinese engineers. The true reasons are a complex of politics, finance, and capacities.

The author justly points out the immense opportunities for airplane development in China, which should be encouraged, not only because railroads are difficult to build through some of the topographic barriers, but more because the chief food lands of China are isolated structural basins in which excellent landing floors are offered. The airplane swiftly passes the intervening barriers—the ranges, rivers, dissected plateaus, and desert basins. The chief difficulty to be overcome is offered by the dullness and suspicion of Chinese officials. I think that quite too much blame has been laid by most writers upon the obstructiveness of a superstitious folk. It was not the folk who tore up the first railroad, but the governing officials. If airplane services were installed and demonstrated, they would accept their benefits gladly. The matter rests with the new government.

Under guidance of English, German, and French experts a very efficient national postal system has grown up, which since 1917 has paid a profit to the Chinese government. The effective service, however, has been seriously injured since 1925 by progressive dismissal of trained European and American experts, by strikes among the employees, and by interference of the military demagogues.

The chapter on trade is devoted chiefly to conditions affecting import and export. Formerly most of the firms were European, American, and Japanese; but Chinese companies are growing up. Difficulties due to language and custom which have hitherto compelled Europeans to deal through intermediaries (the "comprador" system) are being diminished by the spread of the English language among the Chinese, by attempts to simplify the written Chinese language, and by the adoption of western methods of doing business.

The advance toward tariff autonomy was mightily aided by the Washington Conference of 1922 and by the tariff conference of 1925 in Peking. Both of these events are in accord with the rising sense of nationalism, but the Chinese themselves have made little constructive contribution toward tariff autonomy, aside from a vigorous propaganda.

The talent of the Chinese for trade and finance is as undoubted as their talent for art. After the war with Japan foreign banking firms grew rapidly in the treaty ports, and their strong encouraging influence upon the development of Chinese railroads, factories, and commerce is still felt. The larger Chinese banks have been organized chiefly after English models; there is a National Bank of China, and nearly every province has its official bank.

At the close of the paper tables and diagrams are presented. The first table gives the areas of the several provinces with their total population in 1910 and in 1922. Such statistics, however, convey little idea of realities. For example, I read that Shansi province contains 212,000 square kilometers and has 11,080,000 people. Actually the vast majority of them dwell in the graben basins of Pingyang, Taiyuan, and Tatung, while the broad upland of the Shansi Highland is very sparsely inhabited.

The paper is without bias, is condensed to the utmost, and is crowded with carefully sifted information. It can be used with profit by teachers of geography, and by others who need a rapid review of present-day conditions in China.

FREDERICK K. MORRIS

SOME RECENT GULF STREAM STUDIES

V. I. PETTERSSON. **Étude de la Statistique Hydrographique du Bulletin Atlantique du Conseil International pour l'Exploration de la Mer.** 17 pp.; map, diagrs. *Svenska Hydrogr.-Biol. Komm. Skrifter, Hydrografi 1 (N. S.)*, 1926.

OTTO PETTERSSON. **Der Golfstrom und der Atlantische Strom.** 7 pp.; maps. *Ibid., Hydrografi 4 (N. S.)*, 1927.

C. E. P. BROOKS. **Effect of Fluctuations of the Gulf Stream on the Distribution of Pressure over the Eastern North Atlantic and Western Europe.** 36 pp.; diagrs. *British Meteorol. Office Geophys. Memoirs No. 34*, 1927.

J. W. SANDSTRÖM. **Über eine eigentümliche Zweideutigkeit beim meteorologischen Einfluss des Golfstromes.** Map, diagr. *Gerlands Beiträge zur Geophysik*, Vol. 15, 1926, pp. 67–70.

J. W. SANDSTRÖM. **Über den Einfluss des Golfstromes auf die Wintertemperatur in Europa.** Diagrs. *Meteorol. Zeitschr.*, Vol. 43, 1926, pp. 401–411, Brunswick.

The northerly flow of the waters in the great current system that goes under the name of the Gulf Stream transfers a considerable quantity of heat from lower to higher latitudes, which is reflected in the climatic features of northwestern Europe. Fluctuations in the flow of the Gulf Stream are known to occur. What climatic effects do such fluctuations bring in their train? Furthermore, since it is a long circuit that the waters of this current must traverse from the place of origin of the Gulf Stream in the subtropical regions to the coasts of northwestern Europe—one that takes many months to complete—how long a period intervenes between fluctuations in the Gulf Stream and the resultant climatic effects in northwestern Europe? It is to these questions, in one form or another, that the studies here under review address themselves.

In his "Étude de la Statistique Hydrographique" Dr. Vilhelm Pettersson examines five areas in the North Atlantic, for which data on the temperature of the surface waters for the fourteen-year period 1900–1914 are at hand, with a view to determining whether any relation exists between changes in the temperature of the sea and meteorological conditions in the neighboring land areas. He finds that the variations in the yearly values of the air temperature at Madeira show a close relation to the variations in the yearly values of the surface temperature of the surrounding ocean. A like comparison between the air temperature at Bermuda and the surface temperature of the Gulf Stream in the same latitude shows no correlation to exist between them.

Examining the surface temperature of the water in the Gulf Stream proper, that is, the current south of the fortieth parallel of latitude, Pettersson finds variations in the values from year to year. These variations are small, almost without exception less than one degree centigrade; but they are quite definite and appear throughout the region from the Bahamas to Cape Hatteras. And, while the variation of a degree or two in the annual temperature of the Gulf Stream may appear insignificant, the effect of this variation in the colder regions toward which the Gulf Stream bears its freight of warm water may be of importance. On comparing the variations in the yearly temperatures of the Gulf Stream proper with the like variations in temperature of the waters north of the forty-fifth parallel of latitude, that is with the waters of the

Gulf Stream Drift after the encounter of the Gulf Stream with the Labrador Current, no relation between the two appears. From this Pettersson concludes that "we cannot hope to obtain forecasts as to the effect of the Atlantic Current upon the climate of Europe from observations made [only] in the waters of the Gulf Stream proper." Taking the temperature of the water in the region between Newfoundland and Ireland, he finds a very fair correlation between the summer temperatures of the water and the rainfall in Ireland and Great Britain in the following year. In conclusion Pettersson points out that this is only a preliminary study and that longer series of observations are required to bring out definite quantitative relationships.

In "Der Golfstrom und der Atlantische Strom" the veteran Swedish oceanographer Otto Pettersson discusses the question whether the so-called Gulf Stream constitutes a single current system or two different currents; namely, the Gulf Stream proper and a wind-drift current which he denominates the Atlantic Current. Making use of the data in the preceding paper, he limits the Gulf Stream to the current west of the Grand Banks of Newfoundland while the easterly flowing current from this region he defines as the Atlantic Current. The conditions in the area around Newfoundland, where the conflict between Gulf Stream and Labrador Current takes place, Pettersson discusses in the light of his well-known views regarding the importance of ice melting in oceanic circulation.

The physical principles involved in the relationship between the Gulf Stream and the weather of northwestern Europe are complex. To unravel these Dr. Brooks in his paper on the "Effect of Fluctuations of the Gulf Stream" studies the weather following fluctuations in the strength of the Gulf Stream by means of statistical comparisons. Since the data available in regard to the volume and temperature of the Gulf Stream are insufficient for the purpose, he is compelled to go back a step and consider the variations in the strength of the winds that give rise to the Gulf Stream. Realizing that variations in the current may arise from variations in the conditions in any part of the long course the current traverses, he studies wind and atmospheric pressure conditions in various regions. The results are presented in twenty-six tables principally in the form of correlation coefficients between the various elements investigated. Summarizing these results he finds among other relationships that the surface temperature of the North Atlantic has a positive correlation with the N. E. trade wind 12 months before and with the S. E. trade wind 15 to 21 months before.

The meteorological intensity of the Gulf Stream is at times measured by the pressure difference existing between Iceland and the Azores. This relationship Sandström finds wholly inconclusive. In "Über eine eigentümliche Zweideutigkeit beim meteorologischen Einfluss des Golfstromes," he shows that for any given pressure difference between Iceland and the Azores two totally different types of meteorological conditions may prevail in northwestern Europe. He finds, however, a positive correlation between the pressure differences Iceland-Azores and the wind direction in the Lofoten Islands. In the direction of these winds he finds an index of the meteorological intensity of the Gulf Stream. In this relationship, too, he sees the possibility of long-range weather predictions.

In his paper "Über den Einfluss des Golfstromes auf die Wintertemperatur in Europa," Sandström brings out the great importance of the Gulf Stream on the climate of northwestern Europe in general and on that of Scandinavia in particular. This influence becomes apparent from the fact that the January temperature in northern Norway is about 45° F. (25° C.) above the January temperature normal for that latitude. As Sandström puts it, "Were it not for the ameliorating influence of the Gulf Stream, Scandinavia, like Greenland, would be covered with ice because of its northerly location and because of its closeness to the sea which favors heavy precipitation; and civilization, agriculture, and forestry, which now thrive here, would be impossible. We may, therefore, here in Sweden truthfully say that we owe our existence to the Gulf Stream."

The mechanism of the heat exchange in winter between the Gulf Stream and the air of northwestern Europe, Sandström finds in two systems of wind movement; an upper air current of warm, moist, Gulf Stream air moving landward and a lower current of cold, dry air moving seaward. It is the interplay of these two air currents that determines meteorological conditions. And in this connection Sandström develops further his suggestion of the use of the wind direction in the Lofoten Islands as an index of the meteorological intensity of the Gulf Stream. Indeed, on the basis of this he constructs a series of thirty-six synoptic charts which picture the winter temperatures of all of Europe for different directions of the wind in the Lofotens.

H. A. Marmer

Peat Studies in Southeastern Canada

Väinö Auer. **Stratigraphical and Morphological Investigations of Peat Bogs of Southeastern Canada.** 62 pp.; map, diagrs., ills. *Communicationes Inst. Quaest. Forest. Finlandiae No. 12.* Helsingfors, 1927.

Assisted by the International Education Board and the Geological Survey of Canada, Dr. Auer of Helsingfors in 1926 examined stratigraphically 34 peat bogs distributed from Niagara Falls to Nova Scotia. Some 600 samples were taken. The megascopic plant remains have been determined by Dr. W. L. McAtee of the Biological Survey, Washington. The plant pollen and other microscopic remains have been studied by Auer himself.

Many problems are treated, viz., methods of study, distribution of peat bogs in Canada, kinds of peat deposits, stratigraphic types of bogs, origin and development of peat bogs in the light of stratigraphy, stratigraphy of bogs and the postglacial period, and ancient flora and vegetation.

The poor tundra flora, following the retreating ice edge, and the subalpine flora were shortly replaced by rich floras requiring higher temperature, the migration taking place on a broad east-westerly front. For a long time previous to the end of the subboreal period, deciduous trees played a greater rôle than today. Then also many plants extended north of their present northern limit. *Myriophyllum scabratum*, for instance, now growing in Arkansas and Missouri, occurs as a subfossil in peat bogs in New Brunswick.

Changes of the flora, of the character of the lake sediments, etc., in the vertical sections of the bogs indicate marked alterations of the climate in southeastern Canada and bear witness of the following postglacial stages: (1) dry period, (2) moist warm period, (3) dry warm period, and (4) moist cold period. These are the same periods that have been distinguished in northern and central Europe, where they are known as (1) boreal, (2) Atlantic, (3) subboreal, and (4) sub-Atlantic. The Atlantic period appears to be more distinctly defined in Canada than normally in Europe, while the subboreal and sub-Atlantic periods are less distinct in Canada. The sub-Atlantic period seems to have come to an end in Canada, being followed by a drier stage.

As the first stratigraphic study of peat bogs in Canada the paper is of importance.

Ernst Antevs

The Historical Geography of California

H. R. Wagner. **Some Imaginary California Geography.** Maps. *Proc. Amer. Antiquarian Soc.*, Vol. 36 (N. S.), 1926, Part I, pp. 83–129.

This is an able and well-reasoned paper upon a difficult but ever fascinating subject for research.

The author divides his subject under three main headings: The search for the mysterious city of Quivira; the Straits of Anian myth; and the long-prevalent hypothesis of the insularity of California. Beginning with the search for Quivira, he shows how a chance phrase of Gomara's was probably responsible for many of the errors of cartographers and of explorers interested in this quest during the next century or so. Gomara shared with Peter Martyr the wonderful privilege of having access to such a fund of information concerning new lands, peoples, and products, as no other historians ever had or can have; and the wonder is that so few fundamental errors crept into the digests of these two great collators. Quivira, however, was a particularly hard nut to crack. The original conception as to its existence or location was vague and nebulous; and explorers, no less than historians, are after all but human, and the physical difficulties to be overcome in pushing back a little farther the boundary of the great unknown in a land so inhospitable were great.

Quivira, therefore, wandered over maps and charts, now here, now there; but in the main staying close to the fortieth parallel of latitude where Gomara had tentatively placed it. The search for it became involved with that for a practicable route to Cathay, and the western coast of the continent was bent to the west, the north, and even at times towards the east, in the effort to reconcile accounts and authorities. It is surmised by the author that the voyage of Drake to the west coast of North America may have had as one of its objectives the rediscovery and identification of this mythical city.

The Straits of Anian next appeared as a complication in the geography of the great new ocean, which, as was now generally realized, lay between the regions which the Spaniards were so busily exploring and exploiting and the coasts of China.

The lure of a short route to this land of wealth and mystery kept alive the interest in the Straits for over a hundred and fifty years, and California was much involved in the tale and quest. The southern or western entrance was at times surmised to lie as far south as the head of the Gulf, and the strait itself to penetrate the heart of California towards a great central sea.

The author's identification of the name Anian with the Ania of Marco Polo is doubtless correct, and attention is called to the critical decade from 1560 to 1570, in which map makers began to make common use of the name. He follows the generally accepted statement that the first definite use of the word, associating it with the strait, is to be found in Zaltieri's map of 1566, although, as the writer of this review has pointed out (*Bull. Amer. Geogr. Soc.*, Vol. 47, 1915, p. 165), the name Ania was used by Gastaldi in his map of 1561, and Anian by Martinez in 1562 as the name of a contiguous region.

Passing to the subject of the long-prevalent belief of geographers and map makers in the insularity of California, the author enters a field of research more frequently covered. He advances a rather novel theory in explanation of the genesis of this belief, into which the name of Drake again enters. The connection is through one Nicholas de Morena, or Morera. This man is supposed to have given an account to the Governor of New Galicia of having been put ashore by Drake upon what may best be broadly described as the Pacific coast; then of wandering for four years toward the New Mexican settlements and crossing an arm of the sea en route. This account, it is conceived, was used and misconstrued by Father Antonio de la Ascension, who had been a member of the Viscaino expedition and thereafter made several maps of, and became an authority upon, the western coast.

The next link in the chain of circumstantial evidence is the Englishman, Henry Briggs, one of whose maps of the region was published by Purchas in his Pilgrimes in 1625. The author is quite correct in his statement that this map of Briggs depicted an entirely new California and that it was extensively copied and made the basis of many subsequent maps.

Reverting to the author's speculations as to the scope and direction of the explorations made by the earlier voyagers, Alarcon, Ullea, and their associates, in and about the head of the Gulf, it is to be feared that he is traversing rather insecure ground.

The delta of the Colorado is such an essentially unstable region that any attempt to reconcile the accounts of expeditions made three and a half centuries ago witn the configuration of the river channels as they exist today, must be highly speculative. It is, for instance, quite possible that in the middle of the sixteenth century the main channel of the river passed close to the group of mud volcanoes at the base of the Cerro Prieto, and it is almost certain that the shallow lagoon, known prior to its recent obliteration as Volcano Lake, did not exist.

The purely physical difficulties of the region were undoubtedly responsible for much of the ambiguity of the earlier charts. The tides at the head of the Gulf are enormous, a vicious bore drives up the estuary at and about the period of spring tides, the mud flats flanking the entrance to the river are almost impossible to cross or find a foothold upon, and mirages are almost constant and very bewildering. In addition to these unsuitable conditions about the critical region of definite juncture of the Californian peninsula with the mainland, the Sonoran coast and the littoral strip behind it are inhospitable and difficult to follow and traverse for lightly equipped expeditions. Exploration in this direction from the small frontier settlements was therefore an arduous matter and not to be lightly undertaken; and this explains the fact that when Father Eusabius Kino came upon the scene, in 1695, nothing had been done to settle authoritatively the question of the insularity of California or to trace to the sea the various intermittent streams along which the small settlements had grown up.

The paper concludes witn an excellent digest of the various journeys and explorations of Kino and his associates and successors and the gradual obliteration of the island myth. It is made more useful to the student of western history by the incorporation of reproductions of several of the better-known early maps illustrative of the various phases of the associated historical errors.

GODFREY SYKES

HISTORY OF THE PERSIAN GULF

ARNOLD T. WILSON. **The Persian Gulf: An Historical Sketch from the Earliest Times to the Beginning of the Twentieth Century.** xvi and 327 pp.; map, ills. The Clarendon Press, Oxford, 1928. 25s. 9½ x 6½ inches.

Sir Arnold Wilson is well known as an authority on the Persian Gulf. He here presents a pageant of its history from the earliest times—"it is not improbable that the Gulf witnessed the first attempts at navigation of the most ancient peoples of whom there is historical record"—to the beginning of the present century. Credit for the chapters on early and medieval history is given to Sir Arnold's collaborator, Mr. H. W. Mardon. The remainder of the book views the scene largely as the growth of English influence in the Gulf from its beginning with early activities of the East India Company to the dominant position held during the last century. One must regret that Sir Arnold's official connections prevent him from discussing in detail the situation as it is today. An introductory chapter provides the physical and human setting, and the reader may also refer with advantage to the author's paper "A Periplus of the Persian Gulf" in the March, 1927, number of the *Geographical Journal.* A valuable appendix summarizes the status of scientific research on the region. In this respect the Gulf offers an alluring field for study. Some excellent surveying has been done on its coast and waters; but its natural phenomena as a whole, its archeology and ethnology have been little investigated.

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MR. SINCLAIR was for several years attached to the U. S. Geological Survey. Subsequently he was engaged in research in economic geology in various parts of the world, including Central America and the northern parts of South America. He is joint author with Theron Wasson of "Explorations in Eastern Ecuador" (*Geogr. Rev.*, April, 1923) and author of "Notes on the Mapping of an Area in Southern Honduras" (*Geogr. Rev.*, April, 1924).

DR. PEATTIE is on the staff of the Geography Department of Ohio State University. He recently spent a year and a half on field problems in the mountains of a half dozen European countries, investigating height limits of culture. He is the author of "College Geography" and several articles, including "The Isolation of the Lower St. Lawrence Valley" (*Geogr. Rev.*, February, 1918).

DR. TROLL, of the University of Munich, who is now in Columbia, has spent over two years in scientific investigation in the Central Andes. Previously he had carried out glaciological and vegetational studies in Europe, his recent writings including "Die Landbauzonen Europas in ihrer Bezichung zur natürlichen Vegetation" (*Geogr. Zeitschr.*, Vol. 31, 1925, pp. 265–280) and "Die jungglazialen Schotterfluren im Umkreis der deutschen Alpen" (*Forschungen zur deutschen Landes- und Volkskunde*, Vol. 24, No. 4, 1926). Dr. Troll expects shortly to return to Germany where he will work up the important results of his Andean studies.

SR. ROMECIN is an agricultural engineer engaged in studying the agricultural problems of his country. In 1928 he made a trip through agricultural sections of the United States for the purpose of studying methods adaptable to Bolivia.

DR. FLINT is assistant professor of geology in Yale University and a member of the Connecticut Geological Survey. He is the author of several physiographic papers. During the last two years he has been making an intensive study of the glaciation of southern New England. The present paper is published through the courtesy of the Connecticut Survey.

SIRRY BEY is Surveyor-General of Egypt. The new "Atlas of Egypt," reviewed in this number of the *Geographical Review*, was completed under his direction and presented by him to the International Geographical Congress at Cambridge, 1928.

MR. MILLER is instructor in the American Geographical Society's School of Surveying. He was leader of the Society's expedition to Central Peru, 1927–1928.

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CAN JAPAN DEVELOP INDUSTRIALLY?*

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INDUSTRIALIZATION has been in progress in Japan for seventy-five years. In the earlier years it was encouraged as a measure of defense, for it was evident to the Japanese leaders that their jealously guarded isolation had been destroyed by the mechanical superiority of the Western nations. It was realized that further advances could be repulsed successfully only with the weapons of the West. Shipyards and arsenals were among the first modern industries to be established. Industrialization promised also to protect Japan against the economic exploitation that had been visited upon India, China, and the other lands of southeastern Asia. Japan was determined to maintain at any cost her political and economic independence.

Industrialization has accomplished its first purpose. Japan remains one of the few independent nations of Asia. She has gained recognition as one of the great powers of the world.

In recent years a new need for industrialization has arisen. The population is increasing very rapidly—in 1927 by approximately one million[1]—and the development of manufacturing is being encouraged to provide employment for the surplus numbers who can no longer look to the land for support. This paper is concerned with the future of Japan as a nation dependent upon manufacturing.

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*This paper is the third section of a study on the development of manufacturing industries of Japan that is being made under the auspices of the Council for Research in the Social Sciences of Columbia University. It is based on an examination of Japanese records and on an investigation carried on by the author and Dorothy J. Orchard in Japan. The first section of the study, "The Pressure of Population in Japan," appeared in the *Geogr. Rev.*, Vol. 18, 1928, pp. 374–401. The second section, "Agrarian Problems of Modern Japan," by Dorothy J. Orchard, will be published in a forthcoming number of the *Journ. of Polit. Econ.*

[1] John E. Orchard: The Pressure of Population in Japan, *Geogr. Rev.*, Vol. 18, 1928, pp. 374–401; reference on p. 374.

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Present Industrial Position of Japan

From the very beginning the Japanese government has entered actively into the development of industry. The government established the first shipyards and arsenals, the first silk filature, the first glass factory and chemical works. At one time or another it has built and operated porcelain works, silk spinning mills, cotton spinning mills, wool spinning and weaving mills, cement and brick plants, plants for soap making, type founding, and paint making, food factories, iron and steel plants. There are few industries in Japan today that do not owe their existence to government initiative. There are few industries that are able to continue without government assistance. In 1927, subsidies were being paid to eleven basic industries, and plans were under way to include twenty additional industries.[2] The list included steel plants, chemical plants, engineering works, aluminum works, shipbuilding, and the merchant marine. Even the all-important industry of Japan, silk reeling, must have assistance. Repeatedly it has been necessary for the government to extend aid to the silk producers. Large warehouses have been constructed recently at Yokohama with government funds in which silk is to be stored for removal from the market in periods of price decline. In some years the government has made loans on such silk, and in other years under a government plan the funds have been advanced by the Bank of Japan and by the commercial banks.

High tariffs have been established to encourage manufacturing. Iron and steel, woolen textiles, rayon, lumber and paper pulp, and chemicals have received special protection. For semi-manufactures, essential as raw materials to the industries of Japan, a system of tariff rebates has been created. Many industries are being assisted through the remission of taxes. In analyzing the present industrial development of Japan one must bear in mind that, whatever its strength or its weakness, it is the result of the direct and continued assistance of the government.

Japan has progressed industrially: of that fact there can be no question. The manufacturing of the period of isolation was the handwork of artisans in small shops. Its product was almost entirely for local consumption. Today Japan has many factory industries, and in the maritime strip between Tokyo and Nagasaki there are a number of recognized manufacturing centers. Products "made in Japan" have been distributed to the corners of the earth. The contrast between 1928 and 1850 is great. It is almost as marked between modern Japan and modern China. It is so striking that the prevailing tendency in the contemplation of the extremes is to lose sight of the actual industrial accomplishments of the country and to exaggerate the degree of progress that has been made.

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[2] *Trans-Pacific*, Tokyo, May 14, 1927, p. 19.

Agriculture Versus Factory Work

Though the comparison is a popular one, Japan is no England of the Orient. In the European or American sense Japan is still far from being an industrial nation. Despite the vigorous encouragement of the government extending over some three-quarters of a century, manufacturing is a minor industry, and the country remains essentially agricultural. In 1925 more than half the population was engaged in agriculture. Among the leading nations Italy and Russia alone are so completely dependent upon the land. Even in such countries as Canada, Australia, Argentina, Denmark, and the Netherlands—all important agricultural lands—agriculture is of relatively less importance than in Japan.

Manufacturing industry of the factory type employs comparatively few workers. In 1926, including the office staff, engineers, foremen, operatives, and casual labor, there were engaged in factories with five or more employees 2,073,000 workers.[3] If comparison is made with 1850 or 1860, the increase is truly remarkable, for there were practically no factory workers in Japan in that period. In comparison with the present population, the number loses much of its significance, for not more than ten per cent of the people of the country are supported by labor in factories.

Not only is the number employed in factories small, but the annual increase has not kept pace with the increase in the total population. Between 1894 and 1926 the increase in factory workers averaged approximately 47,000 a year in comparison with an average annual increase in population of 591,000. In the more recent years the rate of increase has been even less satisfactory. Industry was greatly stimulated by the World War, and the number of workers in factories increased from 1,200,000 in 1914 to more than 2,000,000 in 1921. Then came the post-war depression with its contraction of industry. The 1921 figure was not equaled again until 1926.

Another measure of the progress of industrialization is the size of individual establishments. Though modern industry emphasizes the advantages and the economies of the large unit, manufacturing in Japan is still an activity of the small workshop much as it was in the period before the opening of the country. The large factory is the exception, and in only two groups of industries has it become the dominant unit of production. Because of the nature of their processes and because economic operation is possible only with comparatively large units, the spinning of cotton yarn and the manufacture of heavy iron and steel products are now entirely factory industries.

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[3] As regards statistical material, use has been made for the most part of Japanese official sources including in particular Statistics of the Department of Commerce and Industry, the Financial and Economic Annual of Japan, the Statistical Abstract of the Ministry of Agriculture and Forestry, Annual Returns of Foreign Trade of the Empire of Japan, Statistical Report of Factories of the Department of Commerce and Industry (in Japanese).

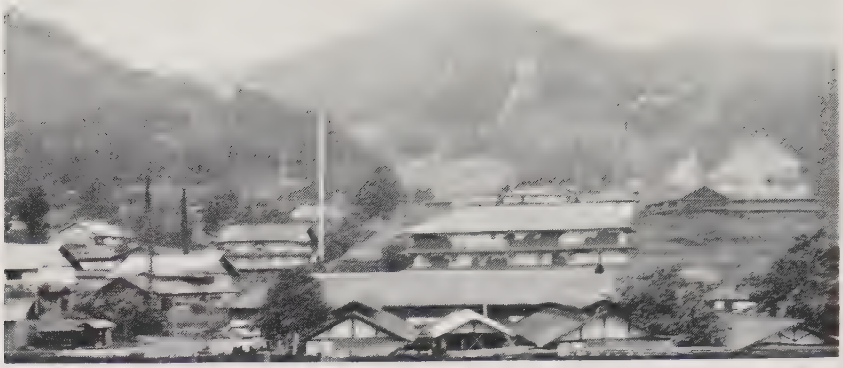

FIG. 1

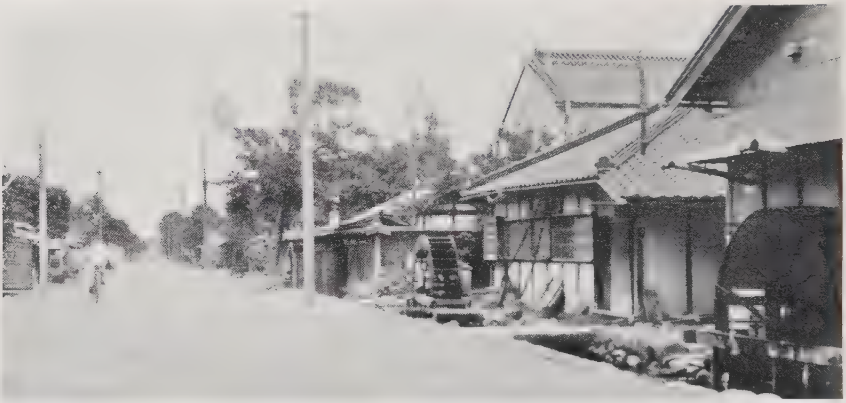

FIG. 2

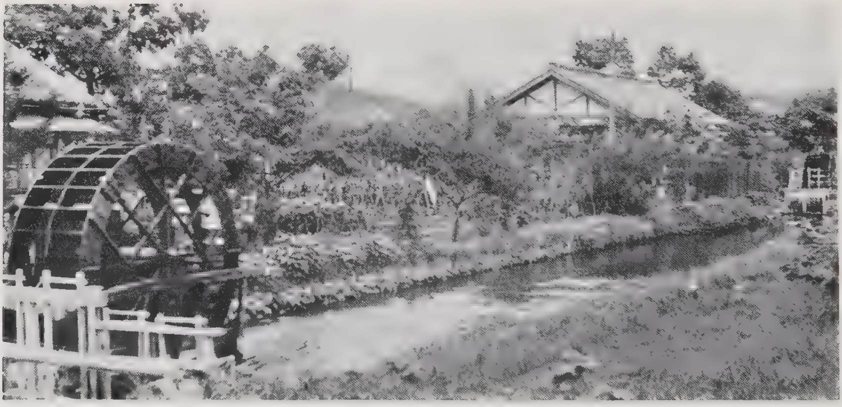

FIG. 3

FIG. 1—Silk filatures in Suwa, the leading silk-producing district of Japan, showing the small size of the buildings.

FIG. 2—A village near Ashikaga. Almost every home is a small yarn-twisting factory. Power is derived from the undershot water wheels in the irrigation canals.

FIG. 3—Close view of two yarn-twisting houses surrounded by rice fields.

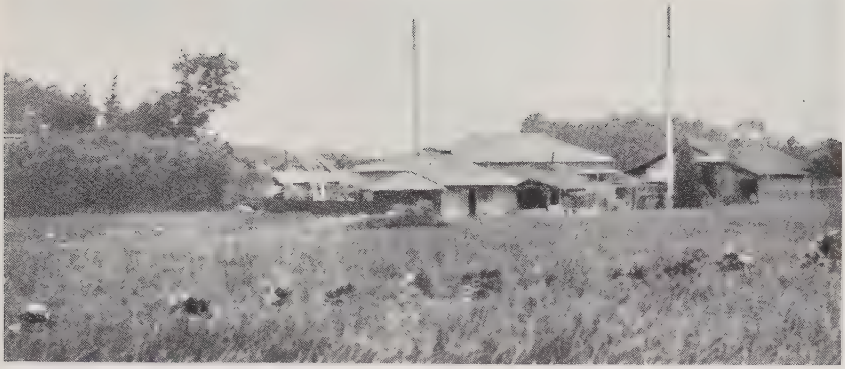

FIG. 4

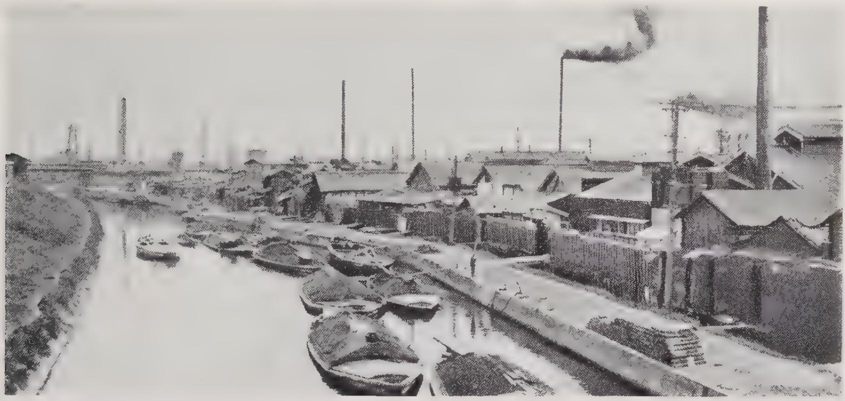

FIG. 5

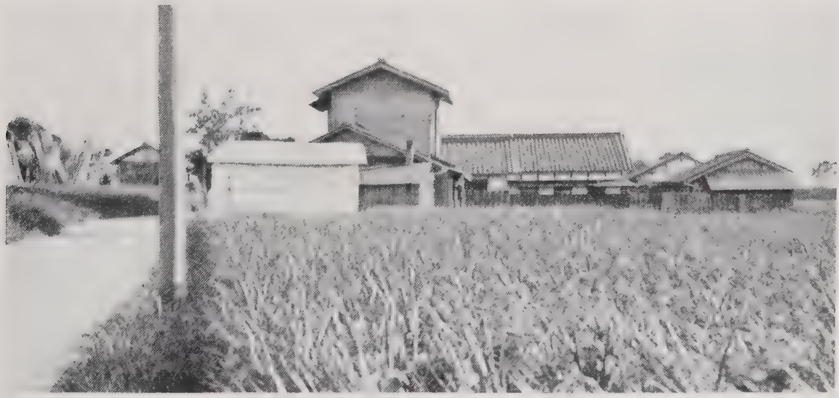

FIG. 6

FIG. 4—A cloth-dyeing and finishing factory in the midst of the rice fields near Ashikaga.

FIG. 5—A portion of the factory section of Osaka. The buildings are mostly one-story, and the establishments are small.

FIG. 6—A small brush factory in a rural area near Osaka. Toothbrushes were being made with hand machines for an American ten-cent store.

In the spinning of cotton yarn over 95 per cent of the workers, in shipbuilding 91 per cent, and in the primary metal industries 73 per cent are employed in establishments with more than 500 operatives. In the other industries the small establishment is a vital unit, if not the all-important basis of production. In 1924, of the factory workers in industries other than cotton spinning, shipbuilding, and primary metallurgy, 49 per cent were in establishments employing fewer than 100 workers, and 29 per cent were in establishments having fewer than 30 workers. In addition to the 3800 filatures of factory rank employing 345,000 workers, there were, in 1926, 74,000 households reeling silk, with an average of slightly more than one worker to the household. Ninety-five per cent of the cotton weaving mills had fewer than ten looms.

The factory statistics include only the establishments employing more than five workers. For the vast number of smaller units complete data are not available, and only through the membership records of a few of the trade associations can their extent or importance be indicated. It is certain that they are very numerous and that they constitute an important part of Japan's industrial organization, if establishments of so small a size can be considered industrial. According to one official estimate, 56 per cent of the operatives in silk and cotton weaving are employed in establishments too small to be included in the factory statistics, i.e. in establishments with fewer than five workers. The most important industry of Kyoto Prefecture is the weaving of silk cloth and of silk cloth mixed with cotton. The factory report states that there are in the entire prefecture only 11,000 workers engaged in that industry. But according to an official of the Kyoto Nishijin Silk Weavers' Trade Association, an association limited to the vicinity of Kyoto City, its members employ 40,000 workers in weaving. The discrepancy with the factory report is explained by the fact that 60 per cent of the members of the association are domestic manufacturers having one or two looms and employing three or four workers. The village of Seto, in Aichi Prefecture, is the leading center for the manufacture of pottery. Its product is the Japanese blue ware so common in America. In the district there is only one factory employing more than 100 workers, and fully one-third of the manufacturers have only domestic workshops with from three to 15 workers. Sakai, near Osaka, is the center of the cutlery industry. There are about 500 manufacturers in the city, most of them employing four or five workers and the largest fewer than 30.

The city of Osaka is the great factory center of Japan, and in appearance it suggests the factory city of England or the United States more strikingly than any other Japanese city. There are numerous large establishments, but small-scale industry is predominant. According to the Municipal Office there were in the city in 1924 about 19,000 industrial establishments, and of that number 13,000 employed fewer than five workers.

The Domestic System in Industry

In a surprisingly large number of Japanese industries contact with the West has produced but slight change either in unit or in methods. Not only has the unit remained small but organization and methods are essentially those prevailing in England before the Industrial Revolution. The manufacture of cotton crepe affords a good illustration of the common type of organization. This manufacture is of especial significance because cotton crepe is the only variety of cotton cloth exported in quantity from Japan to the United States. The leading district for its production is in and near Sano and Ashikaga about fifty miles north of Tokyo. There are in the district a few small factories recently established, but most of the cloth—nine-tenths according to one estimate—is made in the homes of farmers. The unit of production is the jobber, who buys the yarn from a yarn merchant. He sends it to one domestic workshop for bleaching or dyeing, to a second for twisting, and to a third for weaving into cloth. Each of these households engages in agriculture even if that is not the primary occupation, and the manufacturing is the work of the women, the very old, and the very young. The finished cloth is sold by the jobber to a wholesaler who sends it to other domestic workshops for dyeing, printing, or finishing. By the time the cloth is ready for use it has passed through a number of small establishments, each one performing a part of the manufacturing process. Much the same method is followed in the making of Japanese shoes, brushes, cutlery, umbrellas, lanterns, pottery, straw braid, and many other articles. This cannot be called a factory system. It is the old domestic system with any necessary division of labor accomplished through a division of establishment. In the many Japanese industries where this method still prevails the Industrial Revolution has not occurred. There has been no divorcing of the labor from the land and no concentration into factories.

Importance of the Textile Industries

Only in the textile industries has Japan made any significant progress. As shown by Figure 7, the textile group far overshadows all other industrial groups. Indeed, it employs more workers than all the other groups combined. Silk reeling employs almost 18 per cent of all the factory workers and, as the chart shows, is more important than any group of industries outside the textiles. Silk reeling is a comparatively simple mechanical process requiring little power and no complicated machinery. Its product, raw silk, is in reality a raw material but one step removed from its agricultural origin. Though Japan is poor in raw materials for manufacture, no less than 85 per cent, in value, of the raw silk output during the five-year period ending with 1926 was exported, principally to the United States.

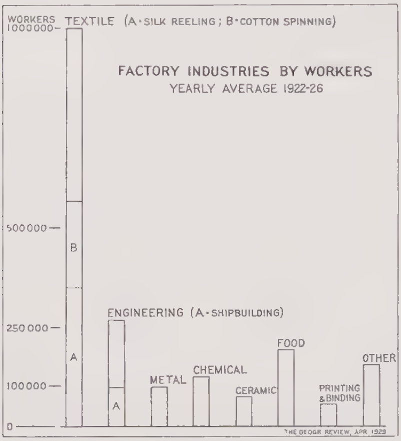

Fig. 7

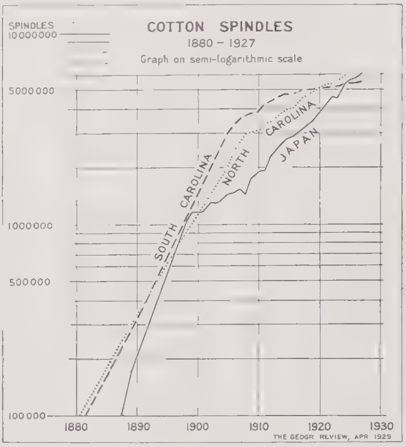

Fig. 8

Fig. 7—The textile industries of Japan employ more factory workers than all other industries combined.

Fig. 8—Since 1880 the increase in the number of cotton spindles in Japan has been almost the same as the increase in North Carolina and South Carolina. (Graph on semi-logarithmic scale.)

Second to silk reeling the most important factory industry is cotton spinning. It was one of the first of the western industries to be introduced into Japan, the first spinning mill starting operations in 1863. It is an industry for which the country is well suited. Its development, however, has been remarkable only in comparison with the Japan of fifty years ago. Though in military and naval circles Japan now keeps company with the United States and England, the growth of her spinning industry in absolute numbers should be compared, not with American progress as a whole, but with the industrial growth of two of the states, North Carolina and South Carolina, the former one-third the area of Japan and the latter one-fifth and both much smaller in population. As shown by Figure 8, the increase in spindles has been almost parallel for the period since 1880. By the end of 1927 Japan had slightly more spindles than South Carolina but fewer than North Carolina. In the period of a little more than 45 years during which the growth of the cotton industry has been similar, the population of South Carolina has increased by only 800,000, of North Carolina by 1,400,000, and of Japan by more than 26,000,000.

The development of the Japanese cotton industry began almost a century after the European Industrial Revolution; and spinning machinery, perfected and ready to install, could be secured from the western countries. Despite that advantage, Japan's progress has been slower than the progress of England even in the experimental stage of the industry. By 1820, within less than 45 years of the date of the invention of Crompton's spinning mule, England had 7,000,000 spindles,[4] or more than Japan now possesses 66 years after the opening of the first mill. Even India has progressed as rapidly as Japan in cotton spinning, for that country now has 8,700,000 spindles.[5]

Minor Importance of Iron and Steel Industries

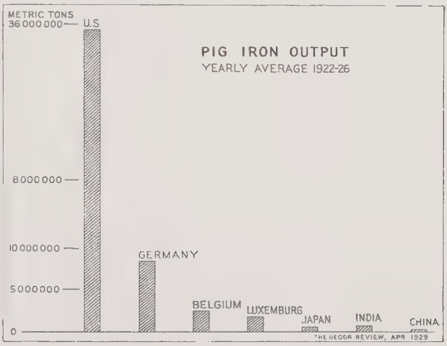

Fig. 9—The annual pig iron output of Japan is less than that of Belgium, Luxemburg, and India, and far below that of the great manufacturing nations.

The output of pig iron is a measure of a country's industrial strength. No nation has ever become a manufacturing nation of major rank without the capacity to produce pig iron in large quantities. In the iron and steel industry Japan's progress has been much less rapid than in cotton spinning. The native iron industry was one of the first to be destroyed with the opening of the country, through the importation of cheaper iron and steel from Europe. Strenuous efforts have been made to establish a modern industry. A huge government plant has been constructed in northern Kyushu, generous subsidies are paid to private manufacturers, and Japanese producers are well protected by a tariff; but, as is shown by Figure 9, the annual output of pig iron is less than that of Belgium and Luxemburg and less even than that of India. The steel capacity of Japan, operating partly on imported pig, is estimated at about 1,500,000 tons a year,[6] or 45 per cent of the actual steel output of Belgium and 70 per cent of the output of Luxemburg for 1926. This capacity, small as it is, was reached only as a result of the somewhat abnormal expansion of the industry arising from the war conditions. At least one of the larger private steel mills constructed during the war has never been in operation, and there is not an iron and steel plant in Japan working at full capacity.

Small Consumption of Coal

In the present day the industrial stature of a country is measured by its consumption of power, especially of coal. Japan is one of the least of the coal consumers. The annual output of the Japanese mines is approximately 30,000,000 tons. Exports and imports very nearly balance and can be ignored. The annual per capita output of coal for a number of countries is shown in Figure 10. Japan's per capita consumption for all purposes is about 0.5 ton a year, in comparison with 4.4 tons in the United States, 4.4 tons in the United Kingdom, 2.2 tons in Germany, 3.9 tons in Belgium, and 1.6 ton in France. Of the European countries at all significant in manufacturing, Italy alone with .23 tons per capita consumes less coal than Japan, and Italy has developed per capita almost exactly twice as much hydro-electric power.[7]

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[4] Andrew Ure: The Cotton Manufacture of Great Britain Investigated and Illustrated, 2 vols., London, 1861.

[5] Report of the Bombay Millowners' Association, 1927.

[6] *Yokohama Trade Rev.*, Yokohama, September, 1928.

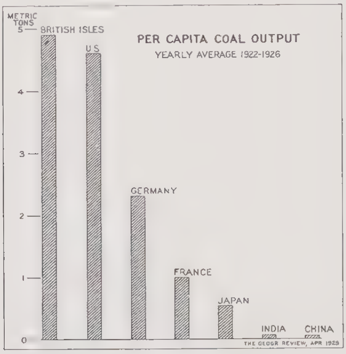

FIG. 10

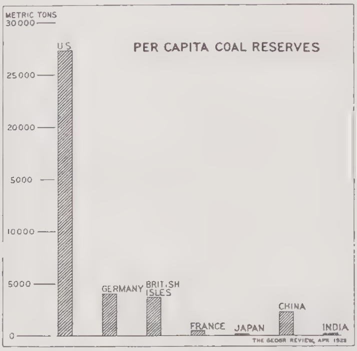

FIG. 11

FIG. 10—The per capita coal output of Japan is very small in comparison with that of the United States and of the industrial countries of western Europe.

FIG. 11—The Japanese coal reserves are very small and cannot be expected to permit a greatly increased output.

EXPORT TRADE

There remains one other measure of the progress of Japan in industrialization—the character of her exports and her balance of trade. Japanese trade has increased tremendously in the last half century; but here again the rate of increase is deceptive, for it has been an increase from practically zero and has been maintained through the great increase in output of raw silk. When the country was opened to trade, raw silk was the most important export, constituting about 35 per cent of the total exports for the five-year period 1871–1875. As shown by Figure 12, raw silk has not only continued to hold its position of importance but has realized some gain: in the five-year period 1921–1925 it constituted 39 per cent of the total exports. Raw silk is certainly not an evidence of a high degree of industrialization for, as has been pointed out, it is the product of a simple mechanical process and must be much more highly fabricated before it is ready for use.

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[7] Estimates from "The Water Power Survey of Japan, June, 1924" (Ministry of Communications, Bureau of Electricity) and W. O. Blanchard: White Coal in Italian Industry, *Geogr. Rev.*, Vol. 18, 1928, pp. 261–273.

Despite the more than one hundred-fold increase in the value of raw silk exports since 1870, Japan has not been able to maintain a favorable balance of trade. In the sixty years for which trade statistics are available, exports have exceeded imports in value in only twenty years and since 1895 in only six years, four of which were during the World War. For the period 1923–1926 the average yearly value of imports exceeded the value of exports by 445,000,000 yen. Japan does have a favorable balance of the invisible items of trade. For the same period the receipts averaged 300,000,000 yen per year in excess of payments, leaving an uncovered adverse trade balance of 145,000,000 yen per year. The adverse balance of trade has been met, in part at least, through government loans. Since 1870 the government has borrowed abroad two-and-a-half billion yen, and of that amount only one billion yen had been repaid by the end of 1927.

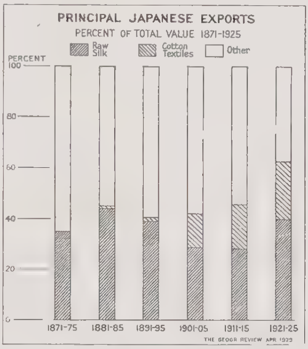

FIG. 12—Since the opening of the country, raw silk has been the most important export of Japan. Cotton textiles have increased notably in the last twenty years.

Industrial Future of Japan

The slow development of manufacturing in Japan and the present weakness of industry, if admitted, are usually accounted for by the short span of years during which the country has been in contact with the West and has had industrial ambitions. But industrialization has now been in progress for seventy-five years, and seventy-five years is not a brief period in modern industry. The present position of industry is the result of the poverty of the country and of other conditions that cannot be easily altered. The causes that have retarded progress are so fundamental and so permanent that, though there undoubtedly will be further development, Japan cannot hope to become a manufacturing nation of major rank.

A country's strength or weakness in industry, realized or potential, depends upon its strength or weakness in capital, raw materials, power, mechanical ability, labor, and markets; and in none of these is the position of Japan satisfactory.

SCARCITY OF CAPITAL

From the earliest establishment of industry there has been a serious shortage of capital. Nitobe has attempted to explain it as a consequence of the Oriental's outlook upon life—his aloofness from material things and his contentment with the present.[8] Perhaps religion and culture have played their part in retarding the accumulation of capital, but it seems more probable that the explanation lies rather in the poverty of the country and in the pressure upon the means of subsistence.[9] There had been little surplus to be stored up from year to year to be utilized later as an agent of production. The shortage is explained also in the absence during the feudal period of any occupations giving rise to a large moneyed class. The people were dependent almost exclusively upon a peasant agriculture barely capable of meeting their daily needs. In England, Holland, and New England there existed a thriving commercial class who accumulated wealth and later supplied capital for industrialization. Indeed, the merchants were instrumental in establishing many of the early industries to provide new commodities for their trade. There were merchants in Japan too, but trade was unimportant and they were relegated to the lowest social rank above only the outcasts. The limited foreign trade through the Dutch was a prerogative of the court of the Shogun. Scarcity of capital has been further aggravated by the conservatism of the people, who still hold to the soil and prefer to invest their savings in land despite the fact that the returns are less than may be secured in industry.[10]

Whatever its cause, the shortage of capital is responsible for a number of the characteristics of present-day Japanese industry. It explains the activity of the government in establishing new industries and in supplying funds. It explains the small size of the units and the continued use of antiquated machinery. It is one of the reasons for night work in the mills, a practice that still continues despite the agreement of the Washington Hours Conference of 1919 and the bitter criticisms of the other textile manufacturing countries.

Capital is fluid, it is true, and may move across national boundaries; but it moves reluctantly into markets that are new and strange. Despite modern inventions in communication, Japan and the money centers of the world remain widely separated in distance and in understanding. Many public and private loans have been floated in foreign countries by the Japanese, but the rate on bank loans within the country is from eight to ten per cent, and even higher, per annum. Scarcity of capital and high interest rate may be only temporary, but for the immediate future they are serious handicaps.

Poverty of Raw Materials

In raw materials Japan is especially weak. By virtue of intensive agriculture and the use of all available land the country is able to produce practically all its food supply; but for raw materials the manufacturing industry is largely dependent on other lands. Japan does produce from her rugged hills and mountain slopes one valuable product, silk; but it has already been emphasized that about eighty-five per cent of the annual output of that commodity, by value, is exported in its raw state.

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[8] Inazo Nitobe: The Japanese Nation, New York, 1912, p. 203.

[9] John E. Orchard, The Pressure of Population in Japan.

[10] D. J. Orchard, Agrarian Problems of Modern Japan.

Though climatically the production of cotton is possible in Japan, the demand for food has reduced its cultivation to a negligible quantity, and the raw material for the industry must be imported, mainly from India, the United States, or Egypt. This is not a serious handicap, however, for both England and New England must import their raw cotton; and the location of the new southern mills in the vicinity of the American cotton fields is an advantage of uncertain importance.

Wool must also be imported from Australia; but wool is highly valuable in relation to its bulk, and transportation in the case of this commodity is not a serious item. The only fibers produced within the country other than raw silk are a little flax and hemp.

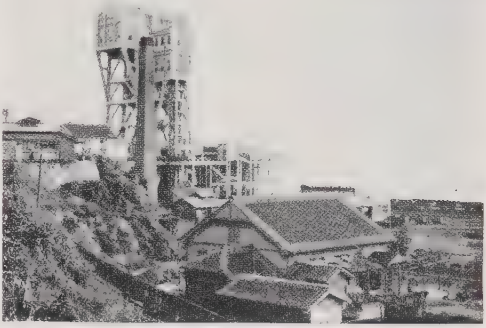

FIG. 13

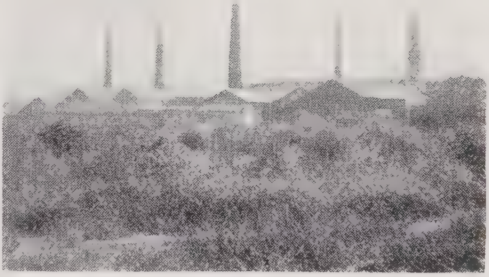

FIG. 14

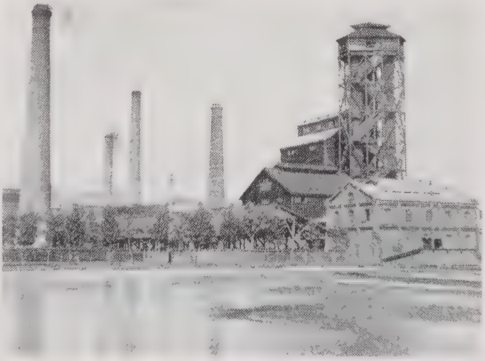

FIG. 15

FIG. 13—In a few industries the modern factory is important. One of the largest paper mills of Japan, the Fuji Paper Company at Ebetsu, Hokkaido.

FIG. 14—The one pottery of factory size in the Seto district.

FIG. 15—Winding house of the Miike mine at Omuta, Kyushu, the largest coal mine in Japan.

IRON ORE

The most vital weakness of Japan is her poverty in iron ore. Though it does occur in many parts of the country, the deposits with few exceptions are too small for blast furnaces of the modern type. The total reserves of Japan proper, including much ore unworkable at present, have been estimated at 80,000,000 tons,[11] or a little more than the output of the United States for one year. The only deposits being worked are a bed of magnetic iron sands situated near Sendai on the east coast of Honshiu and a bed of limonite near Muroran, Hokkaido. The output of the two deposits averaged only 106,000 tons for the four-year period 1924–1927. The iron sands supply ore to the nearby Kamaishi plant. The limonite is used in the blast furnaces of the Japan Steel Works at Wanishi, Hokkaido. The other iron and steel plants of Japan must depend upon ore imported from the continent. The iron ore reserves of Korea have been estimated at from 4,000,000 to 40,000,000 tons. A part of the Korean ore averages as high as 50 to 55 per cent iron content. The output is approximately 400,000 tons per year, which is shipped both as ore and pig to Japan.[12]

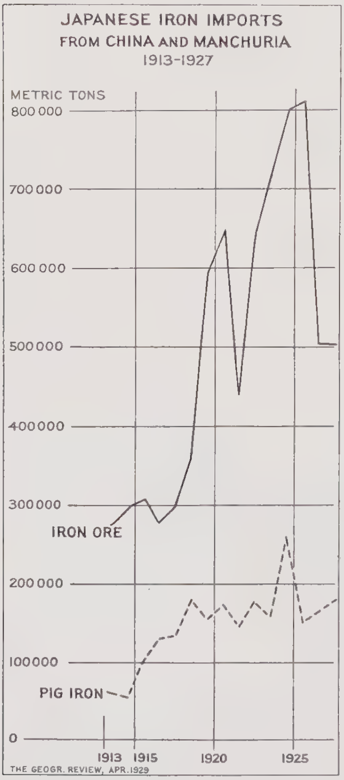

FIG. 16—As a result of the political disturbances in China there has been a decided drop in the Japanese imports of iron ore and pig iron from China.

Japan had hoped to make use of the Chinese iron ore resources and as a result of the Twenty-one Demands of 1915 secured control of the Hanyehping Coal and Iron Company at Hanyang near Hankow and of its iron ore deposit at Tayeh about 80 miles down the Yangtze River. In the development of the works and the mines the Japanese government has expended huge sums of money estimated at from 45,000,000 to 85,000,000 yen.[13] These advances were to be repaid either in ore or in pig iron; but, as is shown in Figure 16, repayments have been neither large nor dependable. It was discovered in 1926 that a part of the loans had been converted by the Chinese war lords to their own use for the equipment of their armies. Since 1925 not more than 15,000 tons of pig have been received from the Hanyehping works, while shipments of ore from the Tayeh mine have been greatly curtailed and for a part of that period, at least, completely discontinued.

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[11] H. Foster Bain: Ores and Industry in the Far East, New York, 1927, p. 98.

[12] J. H. Ehlers: Raw Materials Entering into the Japanese Iron and Steel Industry, *U. S. Dept. of Commerce, Trade Information Bull. No. 573*, Washington, 1928.

[13] *Trans-Pacific*, Tokyo, January 29, 1927; February 5, 1927.

Japan has been able to some extent to meet the deficiency caused by the failure of the Chinese supplies by importing ore from Johore in the Malay States and pig iron from Manchuria and Korea.

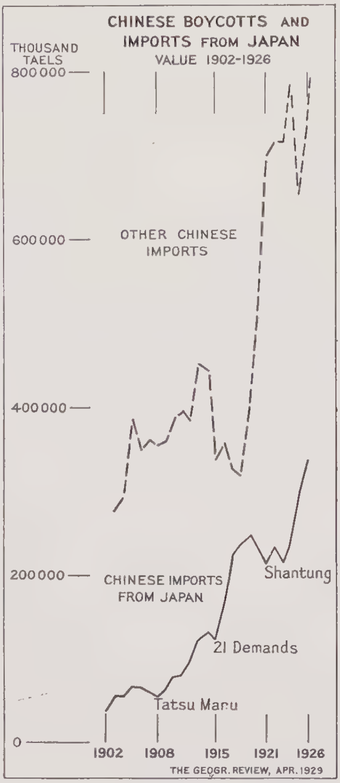

FIG. 17—The Chinese boycotts have been effective in reducing materially imports from Japan and have resulted in serious losses to the Japanese exporters.

Aside from the danger of being dependent upon foreign sources for a material so vital in industry or in war and aside from the certainty that with political unification China will assert her claims to her own resources, the supplies of ore in China are by no means adequate for the development of a large industry. Bain has estimated that the iron ore reserves of China do not exceed a billion tons even if much low grade and inaccessible ore is included.[14] Tegengren, in referring to the Chinese iron ore resources, has pointed out that "the total quantity of iron ore (both actual and potential) . . . would be consumed by the iron industry of the United States within less than nine years."[15] In Bain's estimate of the iron ore reserves of China the reserves of Manchuria are included. The total tonnage is large, being estimated at approximately 700,000,000 tons, but the ore is of low grade. It should be noted that the Manchurian deposits are situated in South Manchuria outside the limits of the Kwantung Leased Territory and are, therefore, nominally at least under Chinese political control. At present no iron ore is sent from Manchuria to Japan. It is made into pig iron at the Anshan Works, and the pig iron is shipped to Japan. In 1927 shipments amounted to 177,000 metric tons.

Japan, by the use of her own low-grade deposits and by the import of ore and pig iron from Asia, may be able to develop an iron and steel industry capable of supplying most of the domestic demands, but it will constitute a further handicap for Japanese industry, for costs of production will undoubtedly be high. It is certain that Japan cannot develop such an industry as the basis for an export trade.

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[14] Bain, *op. cit.*, p. 83.

[15] F. R. Tegengren: The Iron Ores and Iron Industry of China, *Memoirs Geol. Survey of China*, Ser. A, No. 2, Peking, 1921–24.

Japan is almost as poor in the other minerals as in iron ore. In the five years ending with 1926 the value of all minerals produced within the country averaged only $185,000,000 per year, or less than one-fifth the average annual value of the rice crop for the same period. Of the value of the minerals copper accounted for 12.7 per cent and coal for 66.3 per cent.

Copper mining is an ancient industry in Japan, and during the centuries of isolation copper was almost the only commodity exported to the outside world. After the opening of the country the export of copper continued until 1917. Then began a very rapid decline, and by 1919 exports had decreased to such an extent that they were less than the increasing imports. In 1926 Japan exported 2540 tons of copper and imported over 16,000 tons.

It has been shown in Figure 10 that the per capita output of coal in Japan is very small; nor can the country look forward to an increased production of any significance for the total reserves are estimated at only 7.6 billion tons. The per capita reserves of a number of the leading countries are shown in Figure 11. Even at the present rate of output Japan's supply of coal will be exhausted in 200 years; and at the per capita rate of Germany, with no allowance for any increase in population, the reserves would be exhausted in approximately 50 years.

The rank of Japanese coal is on the average fairly high, over 80 per cent being bituminous and sub-bituminous; but very little of it will coke. At the Imperial Steel Works, located at Yawata, within a few miles of Japan's principal coal field, it is necessary to mix imported Chinese coal with the Japanese coal to produce coke, thus considerably increasing the production costs of iron and steel. Because of their small size, the Japanese mines are not efficient. In 1924 there were 184 coal mines that produced more than 10,000 tons of coal annually, and of that number only three produced more than one million tons.

If there is to be any great expansion of Japanese industries, coal must be imported in increasing quantities. China possesses rich supplies of coal, but they are not situated within reach of cheap transport. In the past century the nation possessing the coal has been the one to become the leader in manufacturing. It is not likely that development will be reversed in Asia.

WATER POWER

Japan, because of her mountainous topography and abundant rainfall, has large reserves of water power. In a survey made in

1924 the potential water power, based on the minimum flow of the streams, was estimated at 6,000,000 horse power.[16] The entire amount, however, cannot be counted upon for industrial expansion: 1,700,000 horse power is already being utilized, and of the power that remains to be developed a part will be consumed for domestic purposes and on the farms for drainage and irrigation. There will also be a large consumption in transportation, for plans are already being perfected for the electrification of the Japanese railways. Water power will greatly aid industry and will have considerable influence in determining the trend of its development, but the resources are not sufficient to overcome the handicap imposed upon the country by the poverty of coal reserves. Even if all the undeveloped water power could be brought into use, there would be made available an additional supply of power slightly less in amount than the total now being derived in the country from both coal and water power.

Backwardness in Mechanical Skill

In other countries limited natural resources have been counterbalanced to some extent by a high degree of mechanical skill; but, though the Japanese have gained a reputation for cleverness in imitating, their advance in mechanical and technical proficiency has been slow. It is no reflection upon the Japanese as a race to state that they are not good mechanics. It is a shortcoming that is due to the absence of a mechanical background. During the centuries of isolation, the Japanese were skilled workers in wood. They were artists in the making of weapons and armor of iron and steel, but they knew nothing of the use of the metals in machinery. In a little more than half a century they have been called upon to make a transition in mechanical knowledge and viewpoint that in England required several centuries.

More mechanical progress might perhaps have been made if the Japanese had been forced to master fundamentals, but there were ready at hand the fruits of the Industrial Revolution of the West. It was easy to borrow the mechanical technique and the machinery, and the Japanese industrial structure is borrowed—imported bodily from Europe and America—not always thoroughly understood and still not completely assimilated and adapted to Japanese needs and conditions. In over a hundred industrial establishments visited in 1926 I failed to find a single important mechanical appliance of Japanese invention. There were Japanese machines, but upon close questioning I always discovered that the machine was a copy of a machine originating in England, the United States, Germany, or Sweden. I also discovered that the copies were almost without exception less efficient than the models from which they had been made.

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[16] The Water Power Survey of Japan.

In Japan's leading industry, the reeling of raw silk, mechanical progress has been dependent upon the mechanical advances of the Italian industry. Because of the limitations of her mechanical skill and because of the scarcity of capital, Japan has not been able, however, to keep pace with her teacher. Though a few modern Italian reeling machines or machines designed from Italian models are in use, the great majority of Japanese filatures are still using machinery differing but little from the equipment brought in from Europe in 1873 for the first steam filature.

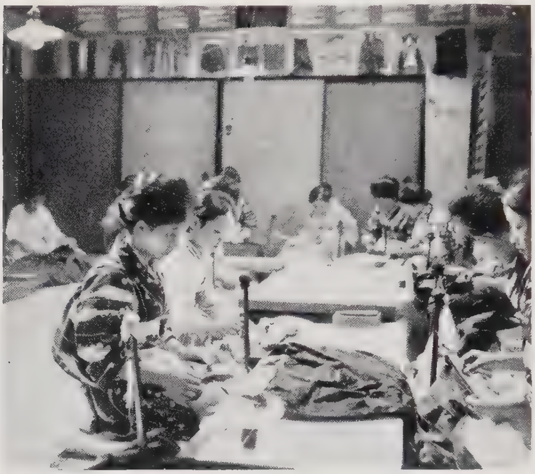

FIG. 18—Workroom of one of the largest establishments making Japanese clothing. All of the work is done by hand.

In capital, raw materials, power, and mechanical skill Japanese industry is handicapped to a serious degree. There remain to be considered the two principal assets of Japan as a manufacturing nation—her labor and her markets. Upon them has been based the present development of the textile industries. In neither, however, is the position of the country secure.

LABOR SUPPLY

In any consideration of the industrialization of the Orient it is always the cheapness and the abundance of the labor supply that is emphasized above everything else. American and European industrialists regard it with both envy and alarm. They covet its cheapness, and they fear the bogey of the industrial yellow peril and of the cheap goods from Asia that are to flood the world. It is a bogey, however, with as little reality as the military yellow peril and can be as easily dispelled. It will be necessary here to point out only two fundamental facts regarding Japanese factory labor: an analysis shows that it is neither abundant nor especially cheap, certainly not as cheap as the western world would believe.

If figures of total population, of density per square mile, and of population pressure upon resources are considered, it would seem that there could be no question of the abundance of Oriental labor. But to be abundant for industrialization, the people must have the inclination to work in the factories; and in Japan and the other densely populated countries of Asia the laboring people have not accepted the factory. Though industrialization has been in progress in Japan for seventy-five years, there is even now no large reservoir of industrial workers. The people are still agricultural, wedded to their land and to their villages; or, if they are industrial, they prefer to be artisans in a small establishment of their own. The cotton spinning mills have adopted the policy of scattering branches throughout the country away from established industrial centers so that they can tap supplies of rural labor. But it is rare that a factory can depend upon the population of the immediate vicinity for its labor. The larger concerns maintain staffs of recruiters who are sent throughout the rural districts, especially those that are overcrowded or have experienced a crop failure. Smaller concerns employ commission agents who bring in the labor at a fixed amount per head. The recruiters make presents to the heads of the rural families, and to the country boy or girl they paint a glowing picture of the opportunities of the factory and of the town. The recruited workers are mostly girls. They are willing to come to the factory for a time to earn extra money, perhaps for their marriage portion. The boys are able to find some occupation on the farm or in the village. In 1926, of all the factory workers in Japan, 51 per cent were women, and in the textile industries 80 per cent were women.

FIG. 19—Interior of typical pottery, Seto. It employs five or six workers. The wheel is turned by hand.

Since the labor is brought to the factory from a distance, it must be housed by the employer. For the girls, he provides dormitories and closely regulates their movements. The gates of the factory grounds are guarded, and the girls are allowed to go out only on special occasions and with permission. The precautions are taken partly to safeguard their morals. They were taken in the past also because a neighboring manufacturer, short of labor, might attempt to entice the girls away. At present there is always the chance that a girl, homesick or dissatisfied with her surroundings, may decide to return home despite the fact that she is under contract for the period of one year.

The workers thus secured and housed cannot be considered a permanent addition to the labor supply. The turnover is very high. In cotton spinning 45 per cent of the girls stay less than one year, and the average length of stay is 17 months.[17] In cotton mills and silk filatures the labor turnover ranges from 40 to 60 per cent a year.[18] The transient character of the labor is detrimental to the development of any high degree of skill.

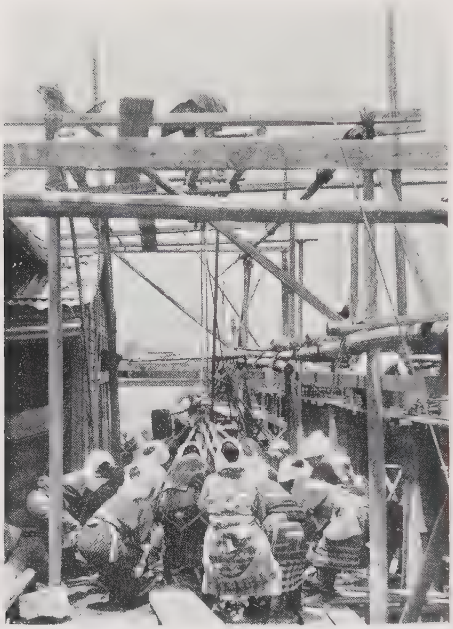

FIG. 20—Driving piling by hand for a reënforced concrete factory building, Tokyo.

In considering the cheapness of Oriental labor, comparisons are usually based upon the wages paid. They are undoubtedly low. In a spinning mill the girls receive on the average 6 cents an hour. In England they would receive 18 cents an hour and in South Carolina 22 cents an hour.[19] These wage figures, however, do not take into consideration the relative efficiency of the Oriental workers. In a Japanese cotton mill from two to four times as many operatives are required as in America for the same count yarn. The comparison in labor costs between Japan and the southern United States, where the product more nearly resembles the Japanese, is presented in Figure 21. Combining wages and efficiency, the third part of the chart shows that the wage costs per pound of yarn are only about one-third greater in America than in Japan. The margin between European and Japanese costs is even less. It must be remembered that in this comparison only money wages are considered. To both American and Japanese wages must be added other items of labor cost, but to the Japanese wage must be added a number of items not usual in America—the cost of recruitment, the cost of dormitories, and the bonus paid upon discharge, a survival of the feudal relation between employer and employee. With these added items the Japanese labor cost is increased, it is estimated, by from 25 to 92 per cent.[20]

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[17] Cotton Mills and Workers in Modern Japan, Japan Cotton Spinners' Association, Osaka, 1919.

[18] Data collected from personal investigation of a number of textile establishments in 1926 and also from Shuichi Harada: Labor Conditions in Japan (Columbia Univ. Studies in Hist., Econ., and Public Law, No. 301), New York, 1928 (estimate made by Japan Bureau of Social Affairs).

[19] Japan Cotton Spinners' Association, Report for 1925 (in Japanese); Wages and Hours of Labor in Cotton Goods Manufacturing, 1910 to 1926, *Bull. U. S. Bur. of Labor Statistics No. 446; Labour Gazette*, 1925 [British] Ministry of Labour.

Even if allowance is made for all these additional items of labor cost, it seems certain that Japanese labor remains cheaper than American; but the margin is not sufficient to offset the many industrial disadvantages of Japan. As manufacturing develops, if it does, the margin will not become wider, even if Japanese labor becomes more fluid and consents to leave the land. International labor standards and the Japanese labor movement, two important forces that have already exerted considerable influence on Japanese wages and hours of labor, can be depended upon to reduce the margin still further.

In some respects the cheap labor of Japan has been a positive detriment to industry, for it has discouraged the efficient organization of the factories and the adoption of labor-saving machinery.

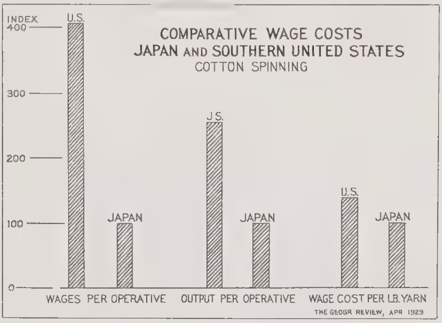

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FIG. 21—Though wages in Japan are much lower than in the United States, the greater efficiency of the American worker diminishes the differences in the wage costs per pound of yarn.

Important Markets for Japanese Exports

Since Japan must look to other countries for raw materials, her economic future depends upon her ability to dispose of her manufactured goods abroad. The importance of foreign markets will undoubtedly be further increased by the necessity of importing foodstuffs. Japan is situated upon the edge of the most densely populated section of the world. In eastern and southern Asia live over one-half of the earth's inhabitants. To the eastward across the Pacific lies prosperous America, a market well suited to absorb the Japanese output of raw silk. Japan's export trade moves in two streams: her luxury product, silk, toward the east; and her staple manufactures, chiefly cotton textiles, to the west and to the south. Figure 12, already referred to, shows the commanding position of silk in the export trade and the secondary and increasing importance of cotton textiles. The two groups of commodities combined in recent years have constituted 61 per cent of the total value of Japan's exports.

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[20] Estimate based upon personal investigation of a number of Japanese cotton mills; Cotton Mills and Workers in Modern Japan, Japan Cotton Spinners' Association, Osaka, 1919; The Japanese Cotton Industry and Trade, U. S. Tariff Commission, 1921; The Kanegafuchi Spinning Co. Ltd., Its Constitution, How It Cares for Its Employees and Workers, 1919.

Figure 22 shows the increasing importance of China and the rest of Asia in Japanese trade. The importance of Asia as a market for Japanese manufactures appears even more strikingly if raw silk, which goes almost entirely to America, is excluded from the exports. The cotton textile industry of Japan is almost completely dependent upon Asia for its export market.

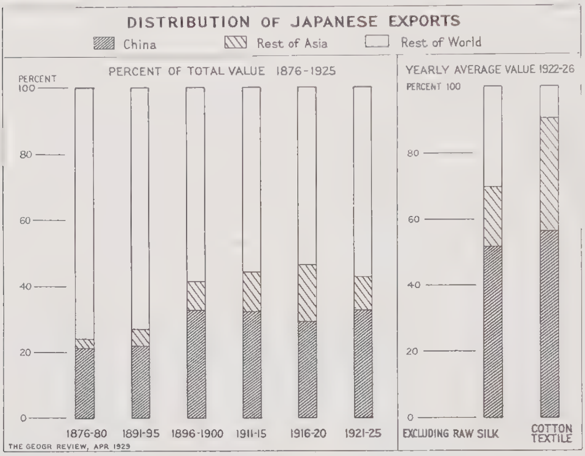

FIG. 22—The relative importance of China and the other countries of Asia in the export trade of Japan. Almost 90 per cent of Japan's export of cotton textiles goes to Asia; and, if raw silk is omitted, almost 70 per cent of all exports goes to the continent.

It is upon these two export streams that Japan's trade depends, and a threat to either would be disastrous to Japanese industry. Both have elements of weakness and danger. The export of raw silk is threatened by the development of artificial silk. The Japanese silk producers contend that rayon is not a competitor of raw silk, and they point to the increasing export of the raw silk to prove that rayon has not made serious inroads upon their markets. The last few years, however, have been years of unusual prosperity in America, and therefore, of great demand for silk. It is a question whether or not without rayon there would not have been an even greater consumption of the Japanese product. It is true that in the same period the Japanese silk market has been glutted on several occasions and that the government has been obliged to provide financial assistance to the producers.

Rayon is being utilized for many purposes for which silk was formerly used; and, if the present progress in its perfection is continued, its uses are bound to multiply. It has had one effect upon the prices of Japanese silk admitted by the Japanese exporters. No longer is it possible for prices of the natural product to rise to very high peaks in periods of deficient supply, for the manufacturers promptly turn to rayon. The substitution of rayon during periods of high prices suggests the possibility, at least, of its substitution at any time, certainly if its costs of production are reduced. It is only a repetition of the oft-repeated struggle between a natural product and an artificial one, and raw silk may be as completely eclipsed by artificial silk as natural indigo has been by the synthetic product.

The Japanese silk exports are threatened from another quarter. China has vastly wider areas suitable for the cultivation of the mulberry and the silkworm. She probably produces more silk today than does Japan; but her methods are careless, and American manufacturers prefer the more dependable quality of the Japanese silk. Schools of sericulture, however, have been established in China; and it is possible that within the next few years the same improvements that Japan has effected may be introduced into China. China will then become a competitor of Japan in the field in which Japan now holds a virtual monopoly.

The other stream of Japanese trade, the export to Asia, is held none too securely. Both China and India have industrial ambitions, and the textile industry is one of the easiest to introduce. Both have cheaper labor than Japan. Both have more coal and richer mineral resources. India has 8,700,000 cotton spindles; and China, though development did not begin until 1890, has 3,600,000 spindles. It seems probable that both countries, as time goes on, will supply their own demands for manufactured goods to a larger and larger degree, and possibly they may even become competitors of Japan in other markets.

There seems little prospect of Japan's extending her market for textiles into other parts of the world. Not only must she meet the keen competition of the nations older in industry and more experienced in trade but, with the wave of nationalism that has spread over the world since the World War, every little nation seems determined to develop a textile industry of its own, protected if necessary by high tariff barriers.

Japan's future in China is especially uncertain on account of her conflicting interests in that country. She insists that a strong power occupying portions of the adjacent mainland would be to her a military menace, and as a result she has annexed Korea and established a sphere of influence in Manchuria to block Russian ambitions. She covets Chinese resources. And, finally, she must have access to Chinese markets. The first two motives, which are necessarily encroachments upon Chinese political sovereignty, are completely incompatible with the third which presupposes the maintenance of friendly relations; and the more successful Japan is in securing control of Chinese territory and resources the weaker becomes her hold upon Chinese trade. The conflict is well illustrated in the story of the boycotts—that most effective economic weapon of the Chinese. Many local boycotts have occurred; but there have been three of national significance, all of them resulting from some overt act of Japan against Chinese sovereignty. Figure 17[21] shows the trend of Chinese import trade since 1902 and presents graphically the effect of the boycotts upon Chinese imports from Japan. The first occurred in 1908 as a result of the Tatsu Maru episode. Though the agitation began in the Canton district and did not spread much beyond the Yangtze River, there was a decline in Japanese trade. In 1915 came the Twenty-one Demands and another boycott. The World War had interrupted Chinese trade with Europe, and Japan seemed master of the field; yet with the boycott Japanese exports to China dropped off sharply. In 1921 there was a third boycott inspired by Japanese ambitions in Shantung, and, though it was a period of rapid rise in Chinese imports, the shipments from Japan again declined. In the last few months numerous local boycotts have been declared as a result of the occupation of Tsinanfu and the Japanese interference in Manchuria, and most recently because of her refusal to accept the new Chinese tariff schedule.

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[21] China, Imperial Maritime Customs, Returns of Trade and Trade Reports, 1909–1925.

Japan is in a quandary—which fact perhaps explains her vacillating policy toward China. Her industries must have the Chinese market as an outlet for their surplus production; but profitable and dependable trade is possible only with a friendly and contented China. China, however, refuses to be friendly and contented as long as the threats to her sovereignty continue. On the other hand, an independent China may conceivably become a strong military power, and the subdued Russian bear may be replaced by a rejuvenated Chinese dragon as a menace to the island empire.

Even if China remains pacific, an independent country will certainly insist upon the control and use of its own resources, and Japan will be poorer than ever in coal and iron. China will endeavor to develop her own industries. For their protection she will establish high tariffs. The tariff schedule, which went into effect on February 1, 1929, is a step in that direction despite its moderation. Whichever pathway China is able to follow, whether it be toward strength and independence or toward weakness and political disintegration, the outlook for Japanese industries and trade is not encouraging.

IN THE LAND OF CINNAMON: A JOURNEY IN EASTERN ECUADOR*

Joseph H. Sinclair

[With separate map, Pl. III, facing p. 216]

IN the year 1539 the Marquis Don Francisco Pizarro, being in the city of Cuzco, received tidings that beyond the city of Quito, and beyond the limits of the empire formerly ruled by the Incas, there was a wide region where cinnamon grew; and he determined to send his brother, Gonzalo Pizarro, that he might conquer such another land as the Marquis himself had found, and become governor of it.[1]

The disasters attending Gonzalo Pizarro's expedition early proved the difficulties of conquering the Land of Cinnamon—the dense forests, the fall-impeded rivers, the appalling weather: in the "provinces" of Quijos and Sumaco, say the chronicles, "during two months it did not cease to rain for a single day."

Into this Land of Cinnamon the writer and Mr. Theron Wasson had penetrated in 1921. In the course of our journey the exact position and the height of the great isolated cone of Sumaco had been determined, but it had not been possible to approach the mountain within 30 miles.[2] The mapping of Sumaco remained an allurement; and September, 1927, saw the writer back in Quito en route to the Oriente.

Plans for Survey Work

It had been our intention to run a traverse line from Quito eastward over the Guamani Pass to the volcano Sumaco and then, after mapping the cone, to explore the unknown region to the north of this mountain. But on our arrival in the capital we received news that there had been a violent volcanic eruption eighteen months or so ago somewhere east of the Andes, that the sound of great explosions had been heard, and that for a number of days the sky had been colored by fine ash. The Director of the Astronomical Observatory told us that he had observed the center of the clouds of ash to lie on a line from Quito passing south of the snow-capped Cayambe (see Fig. 1). It was plain from this and other information that an unknown volcano had come

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* On this expedition I was accompanied by my wife. Our thanks are due not only to the American Geographical Society for its coöperation but also to the government of Ecuador, whose president, Dr. Isidro Ayora, heartily sympathized with our efforts, to the State Department at Washington, and to the New York *Times*.

[1] The Expedition of Gonzalo Pizarro to the Land of Cinnamon, A. D. 1539–42, translated from the second part of Garcilasso Inca de la Vega's "Royal Commentaries of Peru," in: C. R. Markham: Expeditions into the Valley of the Amazons, 1539, 1540, 1639, *Hakluyt Soc. Publs.*, Ser. 1, Vol. 24, London, 1859, pp. 3–20.

[2] J. H. Sinclair and Theron Wasson: Explorations in Eastern Ecuador, *Geogr. Rev.*, Vol. 13, 1923, pp. 190–210.

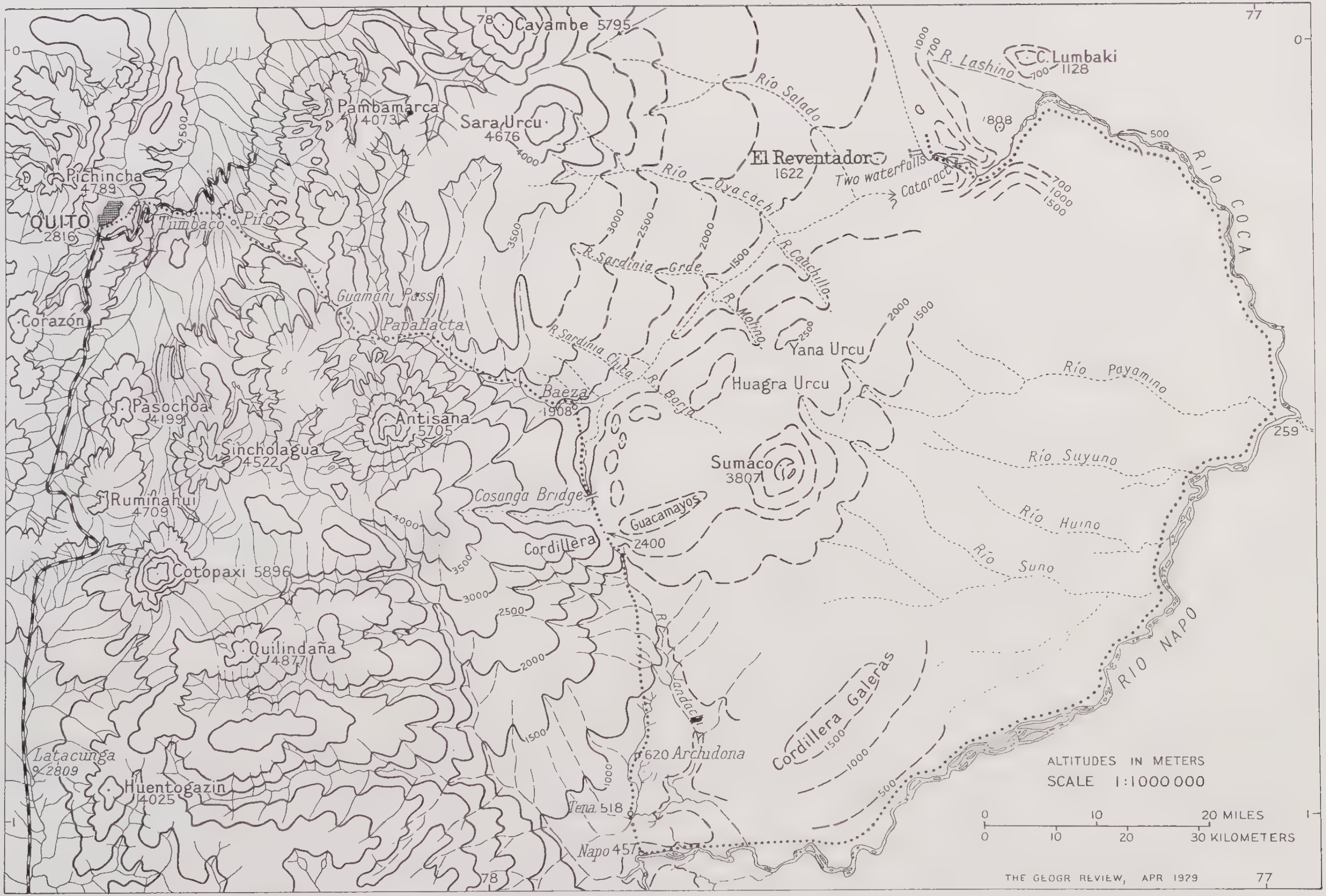

FIG. 1—Map of a part of eastern Ecuador based on the compilation prepared for the Quito and Iquitos sheets of the American Geographical Society's Millionth Map of Hispanic America, showing the route of the Sinclair Expedition of 1927–1928.

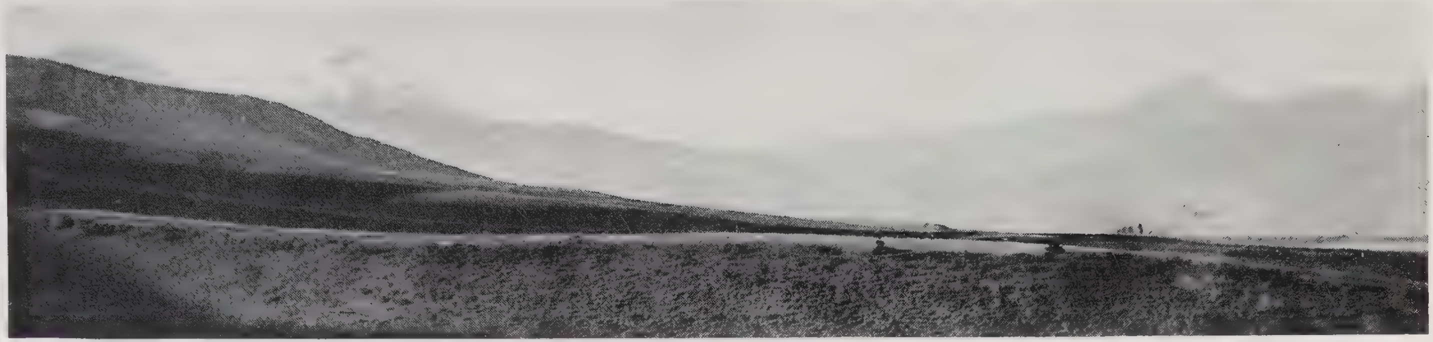

Fig. 2

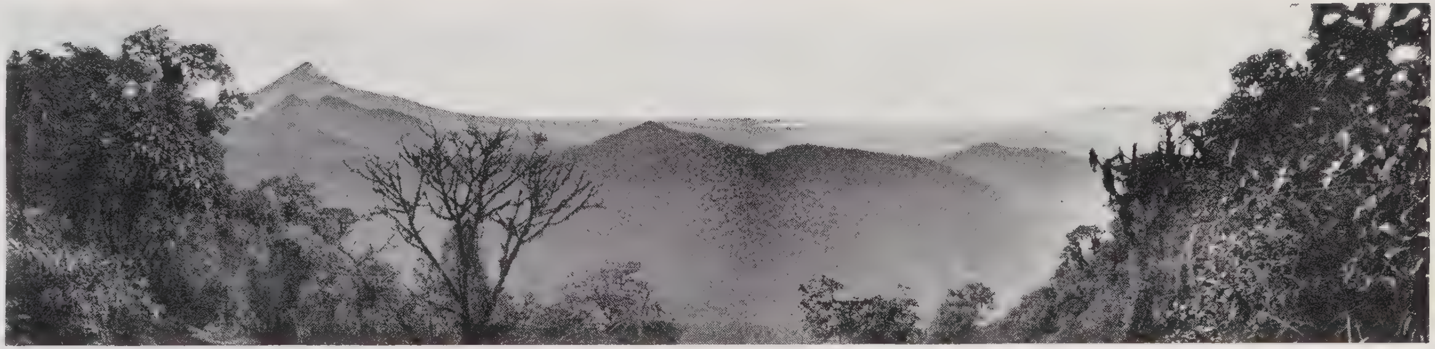

Fig. 3

Fig. 2—View looking north from Hacienda Paluguillo (9432 feet) on the Papallacta trail showing the volcano Cotopaxi at the left and the treeless plains of the Ecuadorean highlands.

Fig. 3—View looking east over the Amazonian lowlands of eastern Ecuador from the crossing of the Cordillera Guacamayos by the Quito-Napo trail (7870 feet.) At the extreme left the volcano Sumaco (12,486 feet); at the extreme right the Cordillera Galeras (about 5000 feet.)

into activity. We decided to modify the Sumaco program and try to locate this new volcano.

From my previous experience of the weather in eastern Ecuador, similar to that of Gonzalo Pizarro, I decided not to try to obtain latitude and longitude positions by the usual methods, which involved carrying a heavy transit for star observations and a radio outfit or chronometer for securing time—and incidentally many sleepless nights waiting to observe stars which only now and then peeped between masses of cloud. Instead I proposed to survey our route eastward from the observatory of Quito, whose latitude, longitude, and elevation were known to be respectively, 00° 12′ 55″ S., 78° 29′ 33″ W., and 9236 feet above the sea, by using a 15-inch traverse table to which were attached sheets of drawing paper, and a Gurley telescopic alidade equipped with magnetic needle and telescopic wires for securing distances by reading stadia rods. The initial magnetic variation of 6° 34′ E. was found at Quito against the true north-south line established by the observatory. We were able to use the stadia rod not only to secure distances but also to carry an exact line of levels from the vertical angles read at each sight, to a point 55 miles east of Quito where we entered the forests. After entering the forests the plane table was used but the distances were obtained by a cotton tape 300 feet long treated with paraffin, and the elevations by a Paulin barometer. The Rio Coca for a distance of about 65 miles was also surveyed by stadia. The plane table outfit enabled us not only to map our route accurately but to secure topographic data on either side of the main route by intersections of points and reading vertical angles to these.

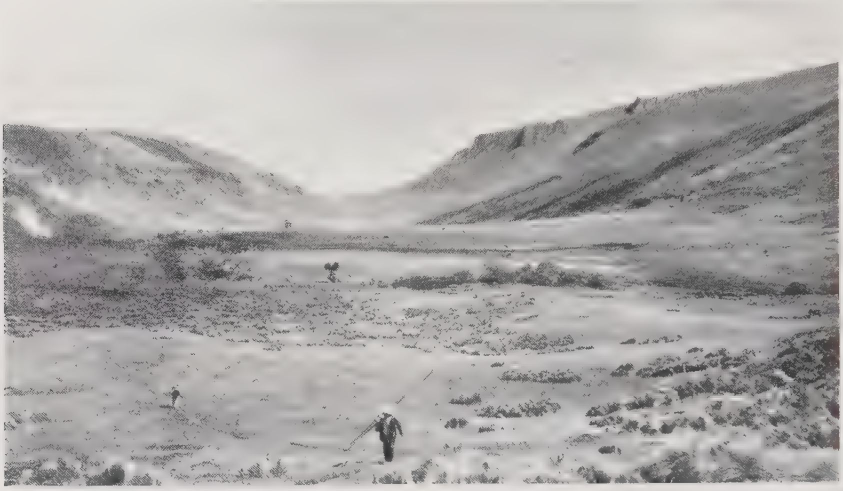

FIG. 4—On the Papallacta trail on the western slope of the Andes about 12,000 feet elevation.

FROM QUITO INTO THE QUIJOS VALLEY

The start from Quito was made on October 3. The first 14 miles of road, passing the good-sized villages of Cumbaya, Tumbaco, and Pifo, can be used by automobiles, and the remaining 42 miles to Baeza can be negotiated with pack animals. A few miles beyond Pifo is Paluguillo, the *hacienda* of our friends Sr. and Sra. Francisco Perez G. It is situated at an altitude of 9452 feet and is the last habitation until Papallacta is reached. The ranch itself extends far into the mountains. The valley, up which the road runs, is wide and walled in by high ridges of volcanic rock. We made our first camp at 11,338 feet, the vegetation here being limited to coarser grasses. The Guamani Pass was crossed at 13,354 feet. A mile and a half beyond the summit is the beautiful lake Sugchoscocha, whose outlet constitutes one of the affluents of the Papallacta River; and three and three-quarter miles farther is Lake Papallacta. Both lakes are narrow, about a mile in length, and apparently formed by lava dams. The tree line of the eastern slope may here be drawn at 11,400 feet. About six miles from the pass is the village of Papallacta (elevation 10,333 feet), reported to contain some 300 inhabitants; but probably this figure includes all the residents of the "parish" of Papallacta and not the village alone which, as far as we could see, contained but a few houses. The inhabitants are very poor and are of mixed Indian and Spanish blood. The village, which lies in a deep gorge, is only seven miles due north of the summit of the great ice-covered mass of Antisana, which towers to an elevation of 18,700 feet above the sea. But we did not get even a

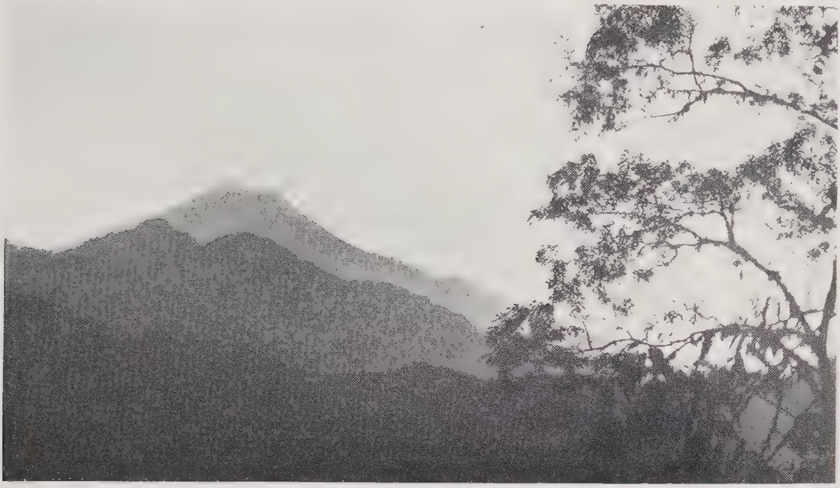

FIG. 5—Sumaco seen from the summit of the Cordillera Guacamayos, 18 miles distant. Compare the view of the other side of the mountain by Commander George H. Dyott, who visited Sumaco in 1925 and secured rock specimens (Fig. 2 in R. J. Colony and Joseph H. Sinclair: The Lavas of Sumaco Volcano, Eastern Ecuador, South America, *Amer. Journ. of Sci.*, Ser. 5, Vol. 16, 1928, pp. 299–312).

glimpse of it while here, for it was covered with mist. The road was excellent for horseback travel, as it had been all the way from Pifo; but the Chalpi bridge, four and a half miles east of Papallacta, and a large part of the government's improvements on this trail were destroyed in the floods of February, 1928.

Some ten miles from Papallacta we were joined by our old friend Manuel Rivadeneira of Napo who was en route with his son-in-law to Quito. In the course of the evening Rivadeneira agreed to make a forced journey to Quito and return to join us. Meanwhile we continued down the river to the confluence of the Quijos and the Papallacta where was obtained a magnificent view of the gorge of the Quijos from the trail several hundred feet above the rivers. We also had our first view of Antisana, whose snow-capped summit just showed above the tops of the near-by wooded ridges. A short distance below this point the south side of the valley of the Quijos is formed for several miles of great cliffs, over which tributary streams cascade. Fifty-four miles from Quito the trail crosses to the right bank of the Quijos River by an excellent bridge constructed in 1924. One-half mile below the junction with the large affluent called the Guagrayacu we came to a cable crossing over the Quijos River, used, we were informed, by several Indians who had small farms a few miles below. Here the *teniente politico* of Baeza, who had come to meet us, told us that the volcanic eruption noted at Quito had not only been observed in this vicinity but that ash had fallen over the entire region and that the flames and noise of the explosions had spread terror among the inhabitants, both Indian and white. Obtaining the direction of the point of eruption from several other reliable witnesses and plotting the bearing to this on our map, we found that it joined the bearing from Quito in latitude 0° 8′ S. and longitude 77° 33′ W.

A study of the conditions from the heights on the south side of the Quijos showed that this valley extended many miles northeast and that the volcano, now more exactly pointed out, must be very close to the river, there known as the Coca, and about 35 miles northeast of where we were. It was agreed that the best way to proceed was to follow the north side of the Quijos Valley, to do which we had to gain the left bank by means of the precarious cable crossing.

The torrential character of the Papallacta and Quijos rivers from Papallacta to the cable crossing is shown by the fact that between these two points the fall amounts to 4470 feet, an average of 210 feet per mile. As will be noted later, the final gradient of the Coca, formed by the above-named and other affluents, amounts to only 19 feet per mile, taking the 59 miles above the mouth of the river, i.e. between an elevation of 850 feet above the sea and 1977 feet. The only other river in eastern Ecuador whose gradient has been carefully studied is the Pastaza, which between Ambato on the Andean highland

8516 feet above the sea and Mera, at the base of the Andes, 3808 feet above the sea, a distance of 87 miles, averages a drop of 54 feet per mile.

At the first house below the cable crossing, occupied by a woman named Mariana Descobar, we decided to await Rivadeneira. However, we soon saw that it would be impossible to continue down the Quijos, for it was impossible to get Indian packers. In this respect our experience was merely a repetition of that of all travelers in the region east of the Andes of Ecuador. We had not expected it to be our lot because of the official interest in our expedition; but, although the government had issued orders to Papallacta and Baeza, the authorities there would not or could not secure the Indians to help us. Rivadeneira, who had rejoined us, started on foot to Quito again to obtain help. In the meantime we moved camp upstream, across the cable crossing to the right bank, and carried on the survey to a point about a mile beyond Baeza (elevation 6260 feet) on the trail to the Napo. We found Baeza to consist of about three huts situated on a low and rather flat spur of a ridge and in a situation favorable for a small village. We were informed that the old Baeza was farther up the ridge and that a number of Indians still lived there.

Route Changed to the Napo

Rivadeneira arrived on the 30th but with only a few Indians, one of whom fell on his knees when he came to our tent and begged not to be taken to the terrible volcano to die. The next day failed to bring the additional Indians promised, and we definitely abandoned the project of descending the Quijos-Coca Valley from Baeza. Rivadeneira believed that there was a possibility of reaching the volcano from the opposite direction, i.e. the east, by proceeding about 50 miles south of Baeza to the Napo River, over the famous or rather infamous Papallacta trail, then descending the Napo 100 miles to the mouth of the Coca, whose position we had accurately determined in 1921, and ascending this river. No one knew how far up the Coca canoes could be poled; but, as this program involved new mapping from Baeza south to the southern base of the Cordillera Guacamayos, which we had reached in 1921, and new exploration on the lower reaches of the Coca, we decided to proceed on this program. Later results proved that we accomplished as much in this move, and perhaps more, than we should have accomplished in the straight descent of the Coca Valley from Baeza.

On November 3 we took up the traverse where we had abandoned it on October 27, reaching a point on the newly-made road about two miles south of Baeza. During the day we succeeded in locating by triangulation the house of Doña Mariana Descobar on the heights bordering the left bank of the Quijos. Vertical angles made this 6035 feet above the sea, while the average of the barometer readings while we were camped there on October 24, 25, and 26, was 6090 feet, the barometer readings, as usual of 10.30 a. m. each day, thus being not greatly different from the true elevation. This house three miles below Baeza, accurately located and with an elevation accurately determined, is an important reference point in future attempts to explore the stretch of the Coca River unmapped by us in 1927.

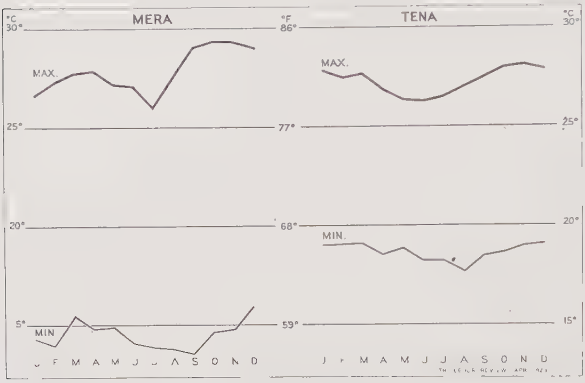

Fig. 6—The graph to the left shows mean maximum and minimum temperatures at Mera (3800 feet) for 1926 and 1927, based on meteorological observations by Charles Newdeck. These and other records by Herr Newdeck are on file at the American Geographical Society. Mean maximum for the year about 82° F.; mean minimum 58°.

The graph to the right shows mean maximum and minimum temperatures at Tena (1700 feet) for the years 1925 and 1926. Observations by the Josephine Fathers.

The following day we entered the dense forests and proceeded by a trail which for 50 miles cannot be described by any better term than "mud wallow." On November 9 we reached the place where the Cosanga, formerly crossed by a cable, was now crossed by a bridge suspended by steel wires about 40 feet above the roaring torrent here 150 feet wide. The bridge, however, had become so dangerous from lack of repairs that its use had been abandoned, the Indians fording the stream about half a mile above the bridge. Leaving the main expedition to follow, I led the way to the ford with three others and, by joining hands and wading in the swift current in water up to our necks, we crossed the Cosanga. The river continued to rise, and the rest of our party were compelled to resort to the bridge, dangerous as it was.

On the 12th we crossed the Cordillera Guacamayos, called by the Indians "Rumi Urcu" or mountain of stone, at an elevation of 7870 feet above the sea. The trail ascending this is in a narrow crevice cut down by the wearing of many feet through centuries of travel to a depth of about ten feet and so narrow that one could hardly drag his body through. It was knee-deep in mud and had been transformed by the torrents of rain into a watercourse.

On the morning of the 13th the weather happened to be clear and before the fog closed in afforded us a panorama of wild beauty. To the east, 18 miles distant, rose the great cone Sumaco towering to an elevation of 12,486 feet above the sea. To the right of this was a vast expanse of tropical forests and to the extreme right and about 28 miles distant could be seen the summits of the Cordillera Galeras, situated north of the Napo and a few miles northeast of the mouth of the Misahualli. Even before we could finish taking two photographs the mist fell over Sumaco.

ARCHIDONA, TENA, AND NAPO REVISITED

On the 15th we camped on the right bank of the Jandachi where Wasson and I had camped in October, 1921. We could now proceed full speed to the confluence of the Coca and Napo rivers without the necessity of carrying on survey work. On the 17th of November we struggled through the seven miles of deep mud to Lara's house, the first inhabited house we had seen since leaving Baeza, 32 miles distant. The next day brought us to Archidona: the first half of the way was indescribably bad; but about four miles from Archidona we reached a really fine piece of road recently constructed, which continued in the midst of small farms to the pueblo. Archidona in 1927 was almost exactly the same as in 1921 except that a church and school had recently been constructed by Italian priests and nuns of the Josephine order.

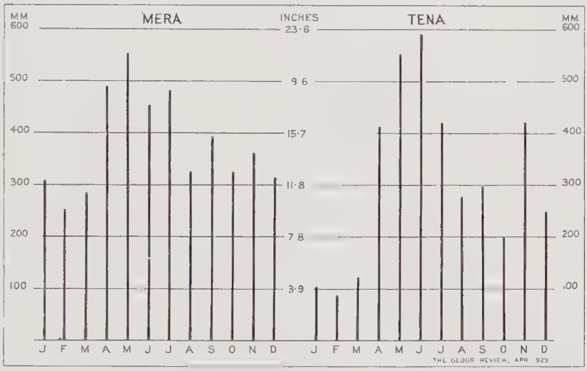

FIG. 7—The graph to the left shows average rainfall at Mera for the years 1922–1926. The rainiest year, 1922, had 220 inches; the driest, 1926, had 149 inches.

The graph to the right shows rainfall at Tena for 1925, when the total fall was 147 inches.

The Papallacta Indians who had served us so well were now allowed to return home after we had given them money and presents. They told us we were by no means as bad as we had been painted!

On the 18th after securing a new supply of Indian packers through the help of Señor Serrano, *Jefe politico* of the district, we rode horseback to the Napo River 10½ miles distant, fording the Misahualli River and passing through the village of Tena. The Josephine padres established a mission at Tena in 1925. There is also a school conducted by two or three Italian nuns of the same order. At the mission headquarters has been established a meteorological station (altitude 1700 feet) which has, next to Mera, furnished the best data on climatic conditions in eastern Ecuador. Observations for 1925, 1926, and the first six months of 1927 show an average yearly minimum temperature of

65.3° F. and an average yearly maximum of 81.3° F., the mean annual temperature being about 73.3° F. The rainfall in 1925 totaled 147 inches. For eleven months of observations in 1926 there was an average of 6.66 inches per month, which would be equal to a total of 80 inches for that year. During the period January–June, 1927, there was a total of 107 inches, an average of 18 inches per month, which if continued during the year would amount to 200 inches. Since our visit in 1921 there has also been established about a mile from the village on the bank of the Misahualli a Protestant mission under the direction of Mr. and Mrs. Larsen. In addition to these institutions the village consists of only about half a dozen houses.

At Napo we were the guests of Manuel Rivadeneira and his family. In 1927 Napo consisted of about five houses, including a church recently built by the Josephine padres who come from Tena from time to time to conduct services. Next to Manuel Rivadeneira, the most prominent resident was an Australian trader who had married an Ecuadorian. We were told that an American resided about a mile down the river but did not have the pleasure of making his acquaintance as he and Rivadeneira were not on good terms. The personal feuds of the few residents in eastern Ecuador add no little to the difficulties of penetrating the country. They arise largely through trouble in securing labor, there being not enough Indians to go around. The other residents of Napo were Ecuadorians with a few Indian servants. As in Tena and Archidona, the Indians live in their huts along the banks of streams away from the villages, where in *chacras*, or small clearings, they raise yuca and plantains, their main food.

The elevation of Napo is only known by barometer. The best determination, we believe, is that based on the average of 12 days' readings of our Paulin barometer at about 10.30 a. m. At this hour we found, from the stadia survey made by us from Quito to about three miles south of Baeza, the readings of the Paulin barometer coincided nearly with the true elevation as obtained by vertical angles. The readings at Napo of about 10.30 a. m. on November 18–26, 1927, and January 2–6, 1928, averaged 1500 feet, which is probably not far from correct. James Orton, who visited Napo in 1865, made the elevation 1450 feet. In 1921 we had determined it at 1680 feet, but this figure was arrived at by taking the mean of all the barometer readings, which with increase of temperature during the day reach a maximum in the afternoon giving an elevation much above the true value.

Down the Napo to the Coca

At Napo we had a great deal of difficulty in securing canoes and Indians for the expedition 100 miles downstream and up the unexplored Coca. But finally on November 26 with three canoes and a large number of Indians and with Manuel Rivadeneira and his son-in-law, Jacinto Bejarano, the *teniente politico* of the Coca, we pushed off into the current and were soon racing through the rapids, swollen by the recent rains. Five miles below we came to the whirlpool "Remolino de Latas," where we had to stop and wait for the waters to recede. On a hill standing on the left bank just above the whirlpool is the home of an Ecuadorian woman pioneer, Juana Arteaga; and here we were welcomed cordially and remained in the shelter of a good house till the 28th when the river had lowered sufficiently to allow the canoes to be roped down the rapids. Cotton and coffee are raised on the little farm, and in addition the flowers of the cinnamon tree called "ishpingo" are gathered and sold in Quito for about 40 cents (American money) per pound. This tree, which is a little larger than a walnut tree, grows to a diameter of 80 centimeters. It is native all along the Napo River for about 200 miles below Remolino de Latas. The bark is also used. It is the famous "canela" that lured Gonzalo Pizarro to the Land of Cinnamon. The coffee raised here is sold in Quito for about $14 per 100 pounds. Cotton brings $18 per 100 pounds in Quito or Ambato. Yuca, the great foodstuff of eastern Ecuador, is also grown, together with the usual plantain.

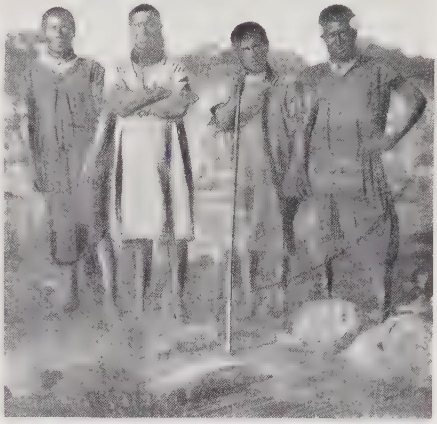

FIG. 8—Cofanes Indians on the Coca River.

On the 29th we arrived at the confluence of the Napo and Coca rivers. We were now 3000 miles from the mouth of the Amazon, only 850 feet above the sea, and the river was half a mile wide. With a steam launch we could sail to the Atlantic.

ASCENT OF THE COCA

Preparations for the ascent of the Coca River had been already started by sending Bejarano ahead to secure Indians on the Payamino River. After a preliminary stadia traverse of 5¾ miles up the Coca from the mouth on December 1, we broke camp early on December 2 and started upstream with the two canoes, leaving word for Bejarano to follow us when he arrived with the Payamino Indians. The Coca here, like the Napo above the mud bank stretch, is a braided stream of many channels and islands and with low banks. We noticed during the day three animals about two feet long, which Rivadeneira called "mitias" (the nutria or coypus?). He said these were amphibians and that their fur was very fine.

Bejarano reached us on December 3 with a number of Payamino Indians, and some of the Napo Indians were allowed to return. We continued poling upstream for seven days more, arriving on December 9 at the mouth of the Lashino River, 45½ miles from the mouth of the Coca. The rapids as we progressed upstream became more numerous and more dangerous. The Indians, however, were kept in good humor as we stopped from time to time to allow them to fish with their nets in blind elongations of the river where there was no current. They caught one strange fish about three feet long with long white whiskers. Rivadeneira called it a "bagre blanco" and said that a similar fish is also found in rivers on the west coast of Ecuador.[3] Most of the fish caught were "boca chica" or "chalua," a sucker type of fish also known, said Rivadeneira, in the rivers of the west coast. Another type of fish, "karachama," was found underneath rocks. It had a sucker-like mouth with an undershot jaw. In the entire stretch of 45½ miles to the Lashino we had not seen a habitation or even an Indian, but evidences at the mouth of the Lashino indicated the near-by presence of Indians. It was decided to remain here and reconnoiter, and on the 10th we discovered a camp of Cofanes, far up the Lashino. Four of these Indians came with us to our camp and agreed to assist us in ascending the Coca, which they said was unknown to them above this point. We remained at the camp till the 12th to enable the Cofanes to prepare for the expedition by toasting large amounts of plantains. The Cofanes differ from the Indians who dwell on the Napo and Payamino rivers in several characteristics beside language. The men wore long gowns made of the bark of trees and had their hair cut very short, in addition plucking the hair of the eyebrows and eyelashes. They were strongly built and proved to be able and willing helpers.

On December 7 we had caught a glimpse of a lofty isolated mass which we thought might be the volcano. This proved to be an unknown mountain, "Cordillera Lumbaki," almost exactly on the equator and standing isolated on the Amazon lowlands. Landslides had exposed near the summit cliffs of bare rock, and we later saw that these were composed of eastward dipping sedimentaries.

The rapids had now become almost continuous and very dangerous. On December 14 we reached the end of canoe navigation. We had arrived at the uppermost part of the braided portion of the Coca: above this point it is a single stream encased in a narrow and deep gorge. We unloaded the canoes, dragged them to what seemed a safe place above ordinary high water, and tied them securely to bushes. Then we moved to a camp site about a mile above, near the base of cliffs 375 feet high. So far we had seen no signs of the volcano, and from the appearance of the canyon we could not expect to ascend it even on foot. Rivadeneira with a few Indians left to attempt to scale the cliffs and proceed west on the ridges. He returned two days later to report the country composed of great canyons all bounded by vertical walls in which he had only been able to struggle a few miles west. In the meantime Bejarano had made a successful attempt to ascend the river a few miles by following the water's edge. It was therefore decided to leave Mrs. Sinclair and Manuel Rivadeneira, who was badly injured by a fall, with most of the Indians, some of whom were ill, and to take the Cofanes and Bejarano and proceed as far as possible up the canyon.

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[3] No lowland species of fish occurs on both sides of the Ecuadorian Andes, but in some cases the genera are identical. Mr. Arthur W. Henn, curator of ichthyology in the Carnegie Museum, who was consulted in the matter, writes: "The 'bagre blanco' is some kind of catfish which has relatives on the western slope. The 'boca chica' of the western slope is *Prochilodus humeralis*, with a different species of *Prochilodus* in the Oriente. The 'karachama' I cannot identify; but it is probably a member of the Loricariidae, or mailed catfishes."

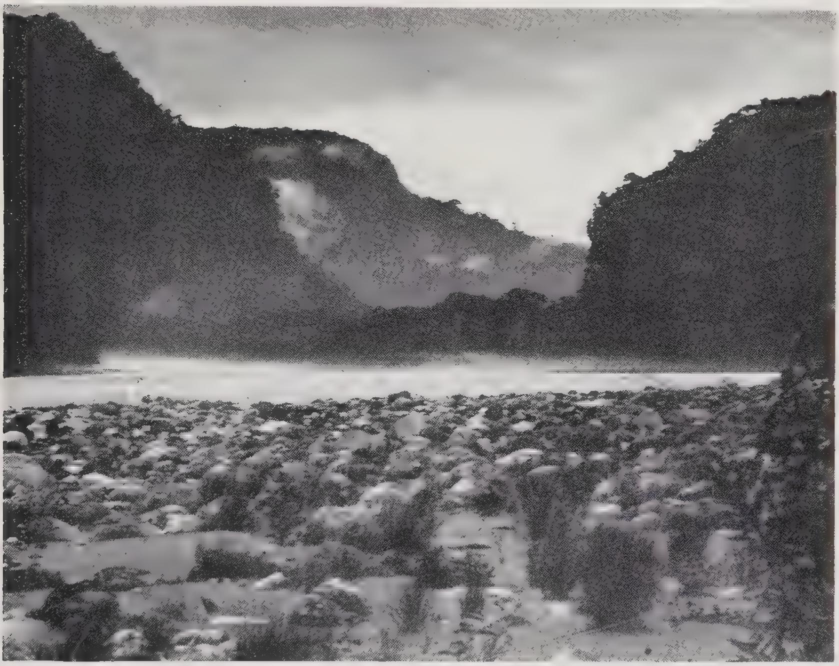

FIG. 9—View up the Coca River from the point where canoe navigation had to be abandoned, 55 miles above the mouth.

On the 18th we carried our survey up the Coca another three and a half miles, passing a large canyon coming in from the south. It rained all day, and next morning the view upstream was still obscured by fog. We started again but proceeded a little less than a mile when we had to leave the river and make our way through the jungle above the cliffs, which impeded our progress at water level. The

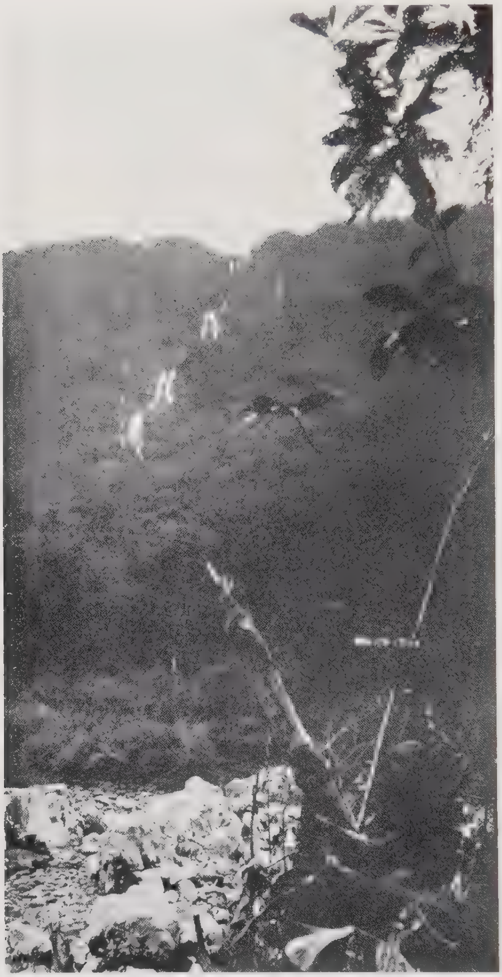

FIG. 10 Cataract on right bank of the Coca River about 59 miles above the mouth. Total fall over 1300 feet.

stadia survey of the Coca thus ended 58½ miles from its mouth at an elevation of 1975 feet above the sea. The survey from this point was continued by alternation of tape measurement, stadia, and pacing. About 60 miles from its mouth the entire Coca River plunges over a fall about 50 feet high in a narrow crevice in the rocks, here igneous. Above the cataract on the right bank through an opening in the trees we had a view of a magnificent cataract formed of a side stream plunging 1300 feet into the Coca. The top of another great cataract could be seen upstream.

The canyon had now become so wild and deep that further ascent scarcely seemed practicable. We decided, however, to make a final effort in spite of continuous rain and fog. About 61 miles from its mouth the river made a great bend to the south. We entered the forests and after a six hours' struggle reached the top of the ridge in our front, 1400 feet above the valley bottom. At dawn of December 21 the mist lifted just above the canyon rim to reveal two great cataracts leaping in three jumps into the 1500-foot-deep abyss below; but hardly had we taken two exposures with the camera when the mist lowered. On the strength of having shot a big black monkey and the certainty of having a good feed that night, the Indians agreed to continue another day.

We moved north about three miles, following the ridge and ascending additional escarpments of sedimentary rocks with cliff faces, and shortly after noon were 1000 feet higher. We had kept near the rim of the canyon all the time. At a favorable spot we put all hands at

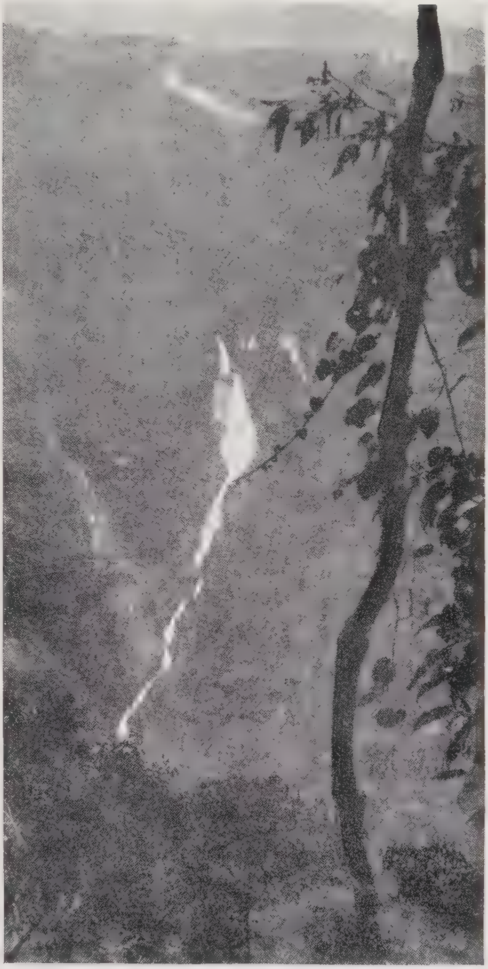

FIG. 11—View of one of the twin falls of the Coca River 60 miles from the mouth. Total fall of each is about 1500 feet.

work cutting down the trees that impeded our view over the cliffs, and as these fell one by one we obtained a surprising view of the country to the north and west for many miles. When the mist had retired from all but the summits of the Andes we discovered that we were on a lofty mesa-topped mountain of nearly 5000-feet elevation which dominated the region to the north, west, and southwest. Evidently it was the mesa we had sighted on December 12, which, owing to the extreme humidity of the atmosphere, had then appeared far higher and more distant. Cayambe was 36 miles to the west. The great gorge which we were following could be distinguished coming in a straight line from far in the north, but we could see no signs of the bend necessary if this river were the one which we had seen flowing northeast at Baeza. But if this were not the main Coca, how account for the great amount of water and the large canyon; and where did we lose the main stream? It will take some additional exploration to determine this interesting question. The cataracts together furnished sufficient water for a large enough river, but we cannot be certain that these represent the divided channel of a single stream as we first thought. The only other solutions are the canyon we had passed on December 18 or a possible junction at the big bend which we could not see.

EL REVENTADOR

While we were examining the country to the north and west, the Indians felled a monarch of the forest to our left which dragged with it down the cliff walls several other trees, and we heard the call "El volcan." Turning, we saw about six miles southwest an isolated mountain composed of a number of sharp and jagged peaks, the highest rising to an elevation of over 5300 feet above the sea. With a small cone-shaped peak a few miles to the south it alone broke the monotony of the rolling forests in the sweep of country before us from the base of Cayambe to the Andes west and southwest of Baeza. This distinctive topographic feature, so unrelated to the general physiography of its surroundings above which it rose for over 1000 feet, coincided with the position of the eruptive center which we had located approximately from bearings taken at Quito and Baeza. As far as could be determined without standing on it and gazing down into the crater of which the peaks probably formed the broken walls, this was the volcano "El Reventador" whose explosion had filled the sky of Ecuador with ash during March and April, 1926.

But, short as was the distance to the volcano, there was a canyon between us over 2000 feet deep with cliff walls very difficult to scale and with a river about 150 feet wide in its bottom filled with rapids that could be crossed only by some sort of suspension bridge. Even if we had the materials for such an enterprise it would be necessary to carry the expedition a number of miles upstream in search of a crossing. Moreover our Indians were without food and were becoming ill, and we were concerned about conditions at our base camp. Obviously it was wiser to return. This decision reached, we moved back at full speed, sliding down the cliffs to the river. Half swimming in the rising waters and half cutting around the cliffs by ascending into the forest, we reached at noon on December 22 the camp ground of December 18–19. Again the cry "El volcan." Looking due west up the river we saw the jagged peaks of "El Reventador," this time standing out clear and near in a favorable moment between the lifting and falling of the ever-present mist, too short, however, to permit the taking of a photograph.

The Return Journey

The 23rd of December proved the wisdom of our forced march to the base camp, for the Coca was a roaring torrent in flood. On the 24th it was still very high; but Rivadeneira and I decided that we could stay no longer and, as by a miracle, we successfully negotiated the nine miles of horrible rapids to the mouth of the Lashino. Here we bade goodbye to the Cofanes Indians. After the distribution of presents to them there was a great handshaking all around. The Napo and Payamino Indians, who had from infancy heard of the Cofanes as cannibals, parted from their newly-made friends with promises to come back to hunt and fish some day.

At the confluence with the Napo it was necessary to reorganize for the hundred miles of poling up that stream. By the 27th, however, we had secured new Indians from below the Coca, thanks to the aid of Jacinto Bejarano, and started upstream. For seven days we poled against the current an average of a little less than 15 miles a day—in itself no mean accomplishment. The arrival at Napo village called for another reorganization, for the Indians from below the mouth of the Coca could not go any farther away. Bejarano, who had pushed on ahead of us, had arranged with Señor Serrano at Archidona for another outfit of Indians; but we had to wait till January 6 before we could get them together. On that date we poled the canoes a mile up the Napo to the mouth of the Anzu and then another ten miles to the head of canoe navigation on this stream, where we disembarked and took to a muddy trail 36 miles across the forests to the Pastaza, which we had surveyed in 1921.

On January 11 we arrived at the village of Mera on the latter stream, a point 3800 feet above the sea where the Pastaza emerges from its great canyon in the Andes onto the Amazon lowlands. This route from the Napo was resurveyed shortly after our 1921 traverse by an American oil company, for the purpose of constructing an automobile highway to Napo from the head of the Pastaza Valley. The proposed highway was to leave the Curaray Railway at Pelileo, 21 miles from Ambato, proceed about ten miles to Baños, 6014 feet above the sea, and then descend the Pastaza Valley 27 miles to Mera, where it was to continue overland 48 miles to the village of Napo, descending the Anzu to the Napo. By January, 1928, this road had been constructed from Pelileo to within two miles of Baños, but it was partially destroyed in February by a great landslide on the slopes of the mountain Carihuarizo which let loose into the Pastaza Valley an enormous amount of water and mud. On January 12 we obtained horses at Mera for ourselves, retaining the Indians to pack our outfit to Baños. We arrived in Ambato on the evening of January 14 and on the 15th proceeded to Quito.

ANDORRA: A STUDY IN MOUNTAIN GEOGRAPHY

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Ohio State University

THE geographic factors back of the anomalous independence of Andorra, lying between two great countries, are Pyrenean rather than purely Andorran. The Pyrenees are not as sharp a divide between France and Spain as they are generally credited with being. At places along the summit of the range it is difficult to judge where the water divide may be. Nor is there a cultural divide, for the Catalans are found in almost equal strength on the two slopes of the eastern end, as are the Basques at the western. The summit of the eastern portion of the range is an uplifted and youthful plain. Here are vast pastures known by the Catalan as *plas*. With pastoral life as a prime element in the existences of both the Spanish and French mountaineers, these pastures are, in summer, the true focus of the local economies. The extent of pasture rights held by the people is as important a measure of the prosperity of the valley communes as is the amount of cultivated land. Indeed the communes frequently hold privileges upon the *pla* land in disregard of the national boundaries. The flocks and herds of the two people mix here. A bond, born of long contact with each other and a common set of economic problems, is established by people of two nations. Though more particularly so in the past, even today the Pyrenees are a zone of transition rather than a sharp boundary between governments and cultures.

So differentiated has this mountain zone been from the flanking plains that the separatist tendency, common to mountain peoples, is here well illustrated. As in Switzerland, there was in this range for three centuries a little-known federation. The mountaineers, regardless of national intentions of Spain or France, maintained a state possessing frontiers, public law, and a political consciousness.[1] This federation was bound together largely by the *pla* terrain. Barèges, an elevated French village, had its communication with the outside world, French or Spanish, by the high-level route until the eighteenth century. It was a *pla* commune. Frequently communes on opposite versants had closer commercial and social relations with each other than with the plains to which they belong nationally if not linguistically. The treaties between such communes, known as *lies* and *passeries* (treaties of alliance and peace), were many, and they involved rights to pasture, water, wood, and commerce. Rights to resources and privileges to trade were exchanged without reference to the national governments and were clung to even when the nations to which the communes belonged were at war. Thus Barèges and Bielsa agreed in 1384 to continue friendly relations in case of war between Aragon and England. Ossau, Aspe, and Baretous were neutral during the Hundred Years' War. In the War of the Spanish Succession the transmontane commercial relations were maintained regardless of the wishes of kings. Indeed republican tendencies are common enough in these mountains. These were the natural results of agreements between communes.[2] The government of Andorra itself is an example of the same historical movement.[3] It is indeed merely a syndicate of villages, which for historical and geographic reasons has persisted into modern times.

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[1] Henri Cavaillès: Une fédération pyrénéenne sous l'ancien régime: Les traités de lies et de passeries, *Rev. Historique*, Vol. 105, 1910, pp. 1–34 and 241–276.

Legend has it variously that Andorra owes its origin to the liberality of Charlemagne and to Louis I (*le Débonnaire*). The fact is that until the thirteenth century it was merely a mountain fief of a certain degree of independence under various seigniories and that at one time or another it owed allegiance to overlords on each side of the mountains. In feudal days rights frequently extended across the range. Thus the counts of Toulouse held Spanish Catalonia, and again the kings of Aragon held French Béarn and Foix. The quarrels between the Spanish bishops of Urgel and the French counts of Foix as to rights in Andorra led to the *Paréage* of 1278.[4] *Paréage* is a feudal term implying equal rights of two lords to a seigniorage. That such a neutral situation should have lasted into the twentieth century may be explained in part by the definite geographic isolation of the little country.

Physical Circumstance

Andorra is officially known, in English, as the Valleys and Sovereignty of Andorra. Its 495 square kilometers (190 square miles) lie largely in one drainage basin, but its main stream, the Riu Valira, has two distinct branches and, in all, six open basins.[5] Hence the term "valleys." These basins are due to unequal resistance of the

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[2] J. A. Brutails: La coutume d'Andorre, Paris, 1904. See also bibliographical references given by Brutails. Brutails is the great authority on Andorra.

[3] Henri Cavaillès: Notes sur les syndicates de communes dans les vallées pyrénéenes, *Bull. des Sciences Économiques et Sociales du Comité des Travaux Hist. et Sci.*, Ministère de l'Instruction Publique et des Beaux-Arts, 1908, pp. 193–301.

[4] Brutails, *op. cit.*, p. 25. Fernando de los Rios Urruti: Vida e instituciones del pueblo de Andorra: Una supervivencia señorial, *Centro de Estudios Historicos*, Madrid, 1920, is also an excellent work.

[5] In order of increasing size the little countries of Europe are: Monaco, San Marino, Liechtenstein, Andorra. In number of inhabitants, they are in the reverse order, if the ranks of San Marino and Liechtenstein are interchanged. Andorra in 1920 had 4309 inhabitants, of which 224 were foreigners. Pyrenean communities have in general been losing population in the last ten years.

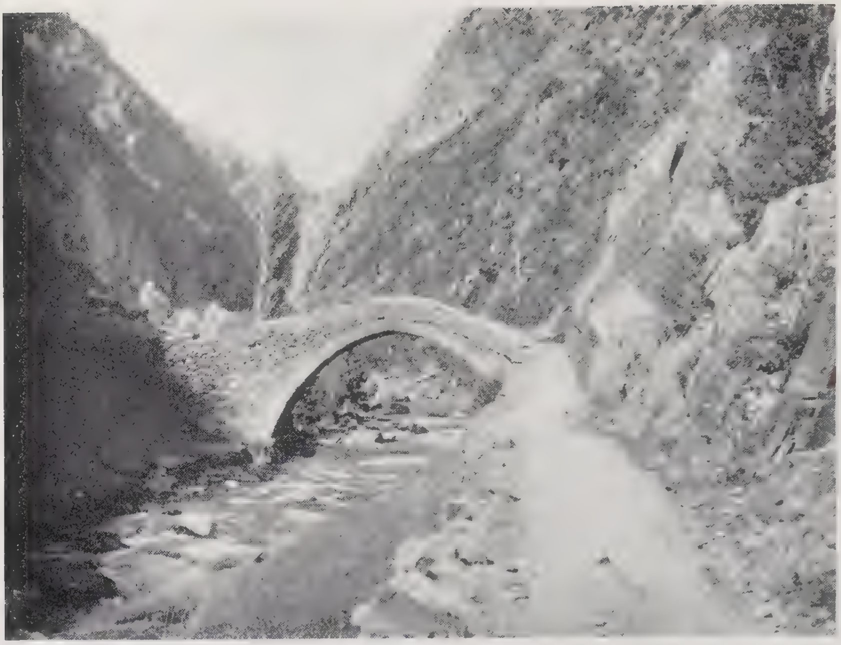

FIG. 1

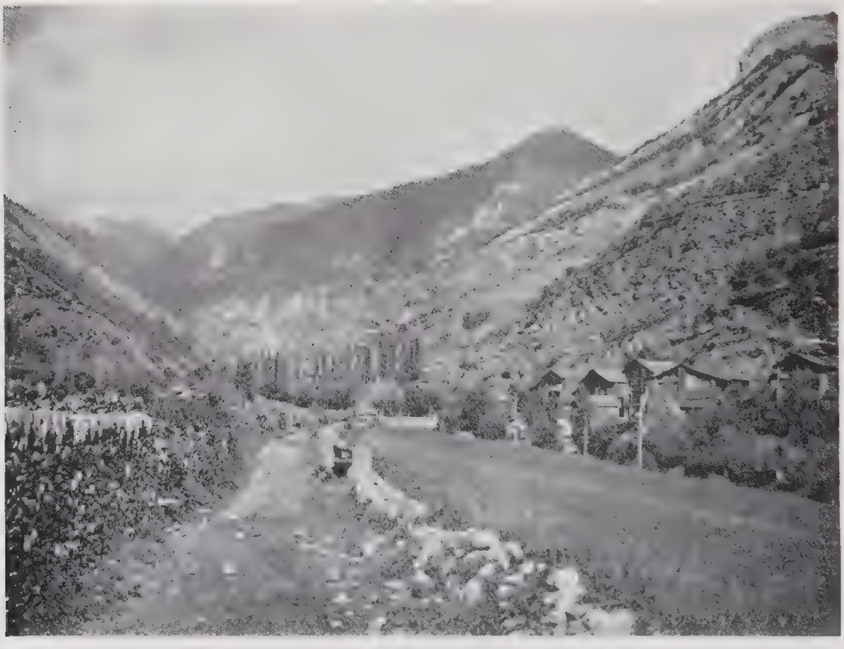

FIG. 2

FIG. 1—Andorra is a land of canyons, shadows, noisy streams, and old bridges. This is the highway, the only road for a dozen communities.

FIG. 2—To reach the hamlet of Arinsal that lies at the foot of the snow-capped mountain one must perforce follow the pathway for hours. The village at the right is built on the hillside to conserve level ground for fields. Above rises a slope too barren for forest or pasture.

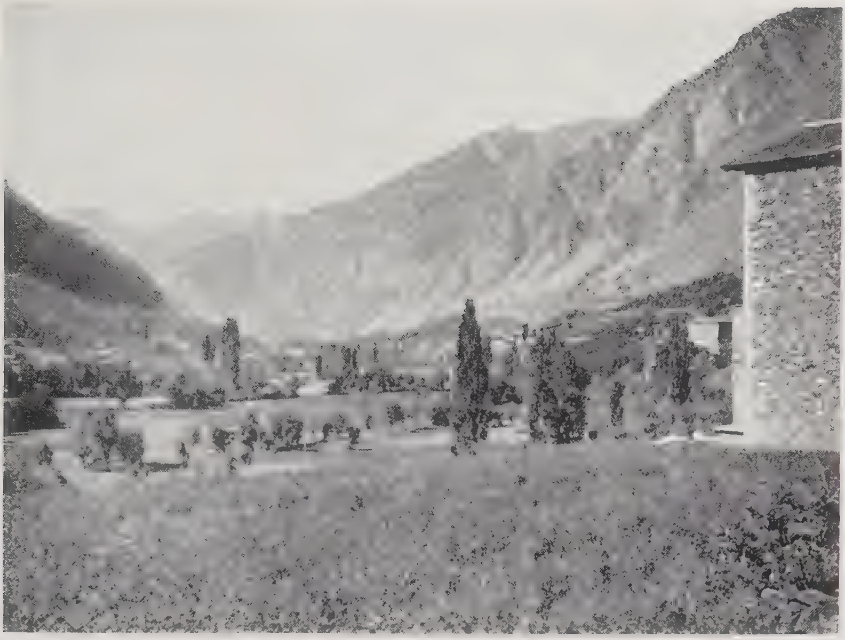

FIG. 3

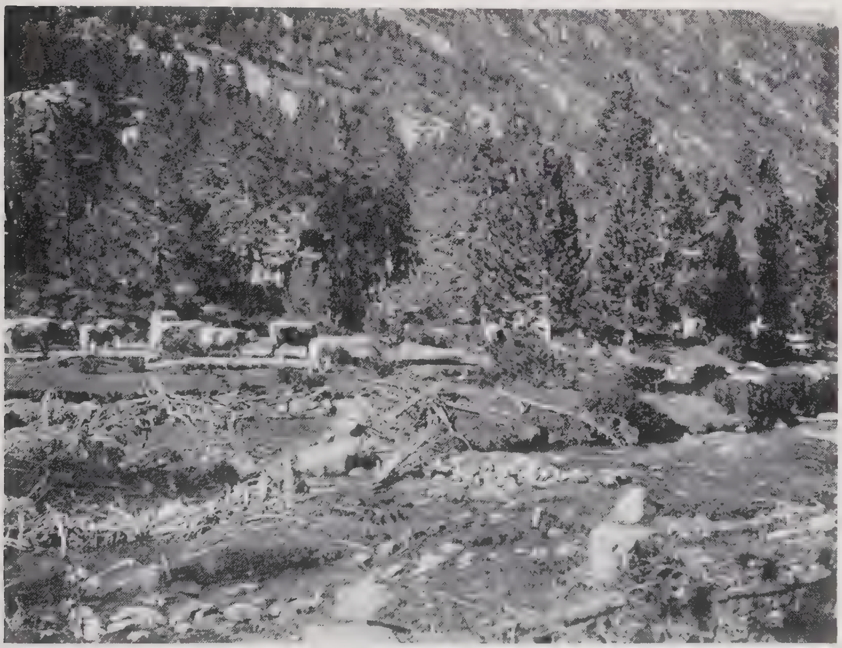

FIG. 4

FIG. 3—The main valley of the Gran Valira is green and fertile. The capital of the country lies just at the right of the center at the base of the mountain. The large building in the distance is a tobacco factory.

FIG. 4—A *coma*. The cows are en route to the valleys of the lowlands after three months in mountain pastures.

metamorphic rocks found in the southern part of the country. The northern portion, referred to previously as the *pla* country, represents the granitic core of the range. There is also much high-level land represented in the southern portion, different in character, however, for glaciation has been much more severe in the more easily eroded rocks. Cirques, compound cirques, glacial lakes, and hanging valleys are common. Both the northern and southern portions of the upland represent summer pastures, but the organization of the industry is different in the two cases. On the *plas* large droves of sheep and goats, largely transhumants from France and Spain, feed in the summer time. The increased precipitation due to the altitude, combined with the levelness and the impermeability of the granite rocks, provides excellent pasture for small stock. The highlands of the dissected southern portion consist of peaks and serrated ridges with steep cirque walls which separate cirque bottoms and high-level valleys. Here the steep slopes have only enough soil and ground water for the mountain pine. The pasture lands are excellent but small areas of valley-bottom soil, *comas*. There are, then, two topographic levels of life in the country—the pastoral and the agricultural. The difference in relief between these two levels is 1000 to 1500 meters. In distinction to mountain nomadism represented in many higher groups of mountains as the Alps, here only a few shepherds take part in the seasonal movement.

The valleys are distinctly glaciated. The forms of erosion are much more dramatic than in most parts of the Pyrenees, and the general aspect of the landscape is savage. The basin of Andorra la Vieja is a little Yosemite. Since glacial times there have been canyons cut, which are still so youthful as to offer serious barriers to communication between the basins. Thus the gorge of Sant Antoine between the basin of Andorra and La Massana has today but a mule path hewn from the rocks. The gorge from Andorra to Encamp has a road along its wall considerably above the stream, but from Encamp to Canillo the trail is forced up 320 meters over the shoulder of the mountain to pass the gorge of Meritxell. The climb is an arduous one for man or mule. The villagers of Mare de Deu and Prats along the route are a half-hour above their valley-bottom grasslands. These last-named villages are on terraces which are lateral moraines. Whereas the glacial terraces in places offer high-level agricultural land, elsewhere the morainic deposits are so rough and strewn with huge boulders as to be impossible for use except for pasturage between the rocks. The French call such an area a "chaos," and indeed they look as if they were portions of the earth unfinished on the day of creation. On the whole, glaciation has improved the Andorran valleys as a place of habitation. The greatest contribution made by the ice was the terminal moraine on which Santa Coloma stands.

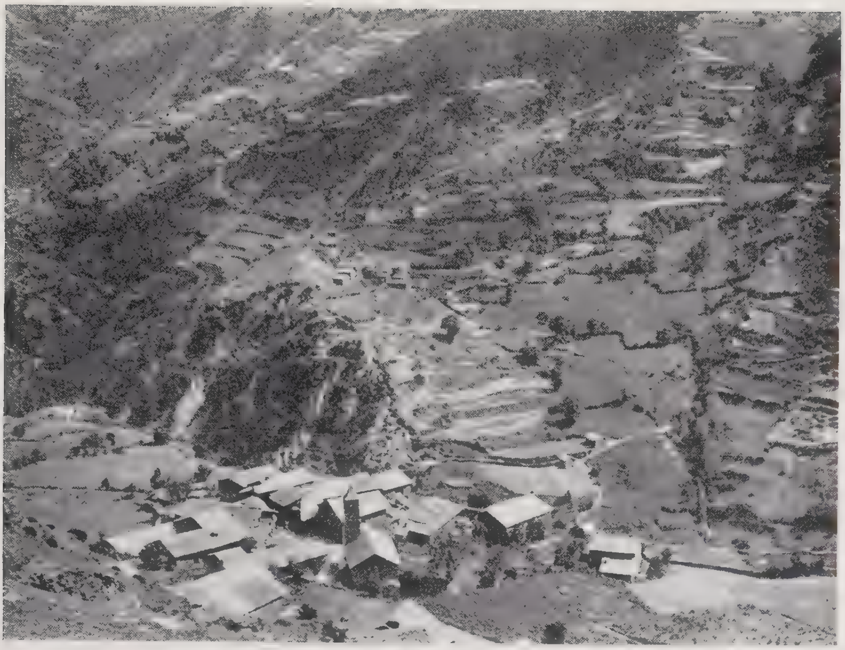

FIG. 5

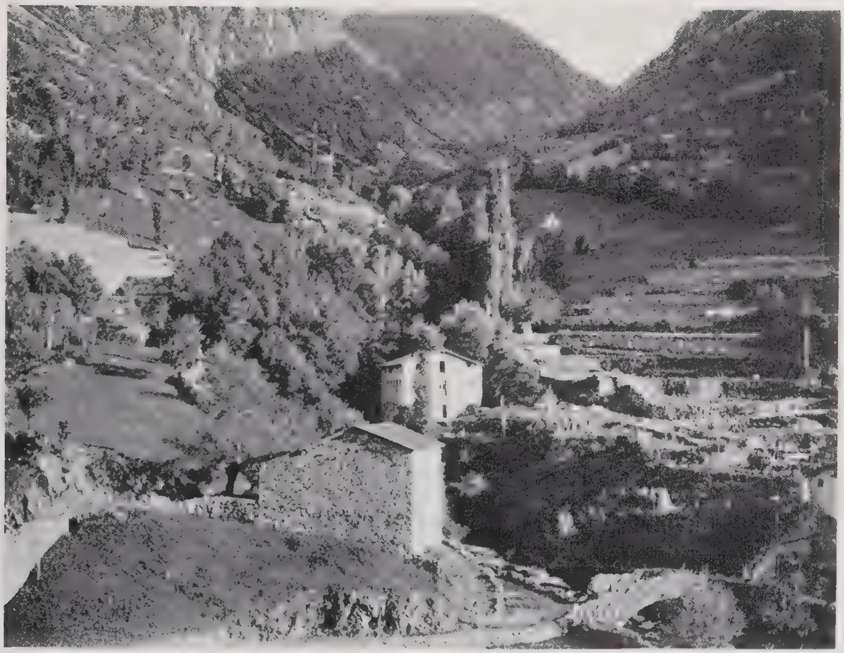

FIG. 6

FIG. 5—Looking across the village of Sispony to the *solana* slope. The fields do not rise above the village on the *ubaga;* but on the better exposures fields are found wherever soil is favorable.

FIG. 6—The valley of Entremesaigues. The *ubaga* and *solana* are here well illustrated. The highest tobacco field of the plain of Andorra lies at the extreme upper end of this canyon (see Fig. 8). The three-storied building is a woolen mill. Note the terraces for fields and slopes for meadows.

A lake of short duration existed in the valley upstream, upon whose lacustrine soils alluvial deposits from the side walls have since encroached.

CHARACTER OF THE FARMING

In lieu of climatic statistics, which are totally lacking, the climate is best discussed in terms of natural vegetation and agriculture. The olive stops at the Spanish gate of Andorra. The chestnut and walnut are found only in the neighborhood of the lowest village, Sant Julia (950 meters). The live oak occupies sunny slopes in the basin of Andorra la Vieja. The climate, always rude, increases in severity very quickly with altitude. Many valleys are entirely subalpine and alpine in character. In less than three hours of thalweg road one may

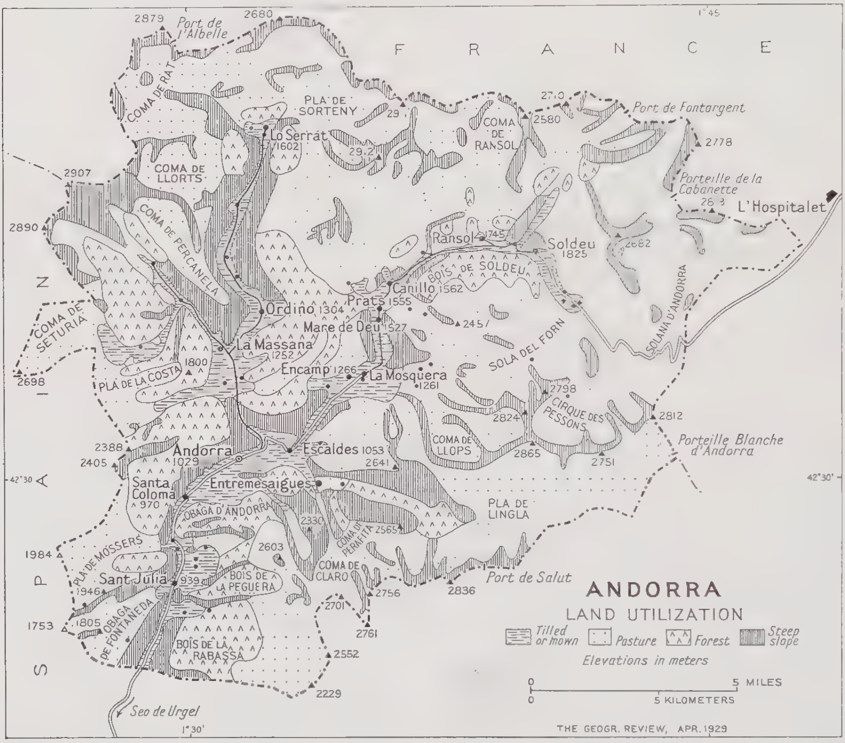

FIG. 7—Land utilization map of Andorra. The area of continuous cultivated fields on the valley bottoms or alluvial slopes is shown, whether irrigated or farmed normally. Isolated fields upon the shoulders of the canyons are not included. Under forest are shown areas of accessible timber of commercial value, chiefly the mountain pine; but the stand varies greatly and generally the board-foot measure is not high.

Land of over 45° slope is distinguished: much of it has slight timber value; most is barren even of sheep forage; some of it has talus which menaces the tilled lands below. The upland pastures include the *plas*, grassy plateaus used largely for sheep, and the *comas*, green parks devoted to cattle and horses. Many of the high knobs of the north are covered with pasture of sorts to the summits; elsewhere it is topography rather than climate that limits the altitude of grass. Mixed forest and grassland has been mapped according to predominant use. The scale is approximately 1 : 290,000.

pass from harvest rye to green rye. On the plain of Andorra (1000 meters) grain is harvested from July first to the tenth. At Encamp (1300 meters) the harvest is nine days later. At Lo Serrat (1600 meters) harvest is not till the twentieth of August when some plowing of fields for the next season's crop has already begun.[6] This rapidity of increasing rudeness of climate is shown by the table of duration of the dormant period of vegetation.[7]

TABLE I—DURATION OF THE DORMANT PERIOD OF VEGETATION

VEGETATION	LOCALITY	ELEVATION (*meters*)	DORMANT PERIOD		
			BEGINNING	END	DURATION (*months*)
Broadleaf evergreens	Plain of Andorra	1029	Dec. 15	Jan. 15	1
Deciduous	La Massana	1252	Dec. 1	Feb. 15	2½
	Encamp	1266	Dec. 11	Feb. 15	>2
	Ordino	1304	Dec. 15	Feb. 28	2½
Coniferous subalpine	Soldeu	1825	Oct. 15	Apr. 15	6
	Cortals d'Encamp	1860	Oct. 15	Apr. 15	6
	Lo Serrat	1600	Oct. 1	Apr. 30	7
	Bordes d'Inclès	1825	Oct. 1	Apr. 30	7
Alpine	Port de Soldeu	2407	Sept. 25	June 1	>8
	Portella Blanca	2515	Sept. 25	June 15	<9

The region is to be classed as of a mediterranean climate in distinction to the dry mediterranean climate to be found in Spain just outside the borders of the country.[8] Farming is both of the irrigated and normal type. Hay, tobacco, and vegetables are grown by irrigation; the cereals are a dry-land crop. All land that is level or slopes that lie adjacent to and below canals on the valley walls are irrigated. These slopes are usually unterraced and devoted to grass. As in all regions where beasts are pastured in the high mountains in summer, the greatest part of the cropped land is devoted to hay production for feed for the animals during the winter stabling. Andorra has an excess of high pasture. Therefore economic pressure for hay land as against field crops is great. The more hay, the more beasts of

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[6] Maximilien Sorre: Les Pyrénées Méditerranéennes: Étude de géographie biologique, Paris, 1913, p. 415. For excellent sections on Andorra see also pp. 29–33 and 412–453.

[7] *Ibid.*, p. 416. For further information on the botany of Andorra see Paul Cousturier and Michel Gandoger: Florule de la République d'Andorre, *Bull. Soc. Botan. de France*, Vol. 60, 1913, pp. 524–531 and 550–557.

[8] Octave Mengel: Caractère climatique de Font-Romeu et de Mont-Louis tiré des conditions générales de la circulation de l'atmosphère dans les Pyrénées-Orientales, *Memorial de l'Office National Météorologique de France*, Vol. 1, No. 5, Paris, 1923, p. 13.

Andorran ownership on the uplands. The number of cuttings of grass varies from one on the natural prairies at the edge of the *plas* to four on the irrigated fields. There is in Andorra, considering the Mediterranean type of climate, a remarkable flow in the streams. That the uplands have a significant duration of snow cover is an element in this condition, but the relative levelness of the uplands as well as the number of lakes plays a part. There is always an excess of water for the amount of land to which it can be easily conveyed.

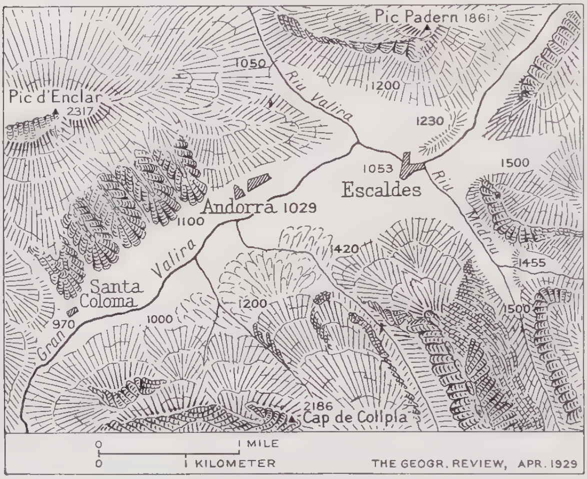

FIG. 8—Sketch map showing the highest limits of cultivation on the plain of Andorra. The highest field is at 1500 meters up the Madriu: here tobacco is grown in a well shaded valley refrigerated by a cold stream and visited every evening by a cold valley wind. None of the limits of cultivation represented on this map are climatic: they are topographic and due to soil conditions. (Based on Chevalier's map of Andorra, 1 : 50,000.)

The cereals are largely rye and barley. The people eat black bread. Where there are gentler breaks in the valley walls and farmable slopes extend up to the *pla* level, rye occupies the top fields. Elsewhere rye is grown on the shoulders of the canyon walls. These highest fields in Andorra lie at 1850 meters and are not infrequently an hour's tramp from the nearest house. The isolated position of the fields represents largely a search for sunlight. The deep gorges and their alluvial cones may have but a few hours of sun during the day: the high fields are out of the gorge on the sunny exposure of the valley.

The question of sunny slope and shady slope is of utmost importance in mountain climates, the more so because at high altitudes air temperatures in the shade are critically low. Each group of peoples has a set of names to correspond to the two slopes. The Catalan calls the sunny slope the *sola*, *solana*, or *solane* and the shady slope the *ubaga*, *obaga*, or *ubach*. Every inch of the *solana* is cultivated, but the *ubaga* almost literally belongs to anyone who wants it. In so far as production goes, the *ubaga* is almost negligible. And yet the *ubaga* is farmed, and the condition of slopes may be so favorable that it is farmed as high as the *solana:* indeed, frequently the greater the altitude on the *ubaga*, the greater the percentage of sunlight. But the crops on the shady side are commonly so slight or even precarious as to have relative unimportance. It may be stated as a principle of mountain geography that the shady slope can be farmed as extensively as the sunny but that the two vary greatly in economy. Also, the higher the altitude, the less the difference in the economy of the two slopes. However, I do not think that the climatic limit of agriculture of one sort or another has been reached by the Andorrans. Matters of accessibility, distance, difficulty of carrying manure to the fields and crops to the granges, and unwillingness to encroach upon pasture lands, as well as unfavorable soils on the *plas*, are factors which all obviously play a part. It would almost be easier to determine a lower climatic limit for grain in the gorges than an upper limit. In the valleys the sunlight duration is so short that the season necessary for maturing grain is lengthened. In places men may sow one grain crop in the autumn before in an adjacent field the grain of that year is harvested. The land must then either lie fallow a year or be put into field crops.

Tobacco is the most distinctive crop of Andorra. It had its start when smuggling was a recognized profession. Today smuggling is no longer what it was, partly because of the unfavorable exchange since the war. Andorra uses Spanish currency, and the peseta is much more nearly normal than the franc. But the amount of tobacco grown in Andorra is far in excess of national needs. I have no confidence that this tobacco pays duties when it is exported, and it would have been a breach of hospitality to have made inquiries. Climatically, the interesting thing regarding tobacco is that the highest cultivated fields in the basins of Andorra and the valley end of high Arinsal are devoted to it. The highest field in the basin of Andorra (1500 meters) lies in the side valley of Entremesaigues. Sunlight duration is short (on September 15, with the tobacco still on the stalk, there was but eight hours of sunlight), the canyon is refrigerated by an icy stream, and it suffers in the evenings from cold mountain winds. Tobacco is everywhere given the best lands. These fields have the advantage of being close to summer pastures and so to manure.

Other agricultural products of Andorra are potatoes, garden vegetables, buckwheat, rye, and barley. A few vines exist near Sant Julia, the lowest community. Vine culture is restricted because with better transportation one is able to buy wines from the Lérida region of Spain, and the grapes are today used for raisins.

There are to the best of my knowledge no areal statistics on land utilization in Andorra. In lieu of exact data I offer the accompanying map. This is based largely upon personal observation, though certain facts for its construction were interpreted from the single existing contour map of the country.[9]

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[9] An excellent contour map on the scale of 1:50,000 with a 25-meter contour interval made by Marcel Chevalier and accompanying his work, Andorre, Chambéry, 1925. M. Chevalier is an authority on the geology and physiography of the country and has published many articles thereon.

PASTORAL ACTIVITIES

As with many mountain communities, the true basis of Andorran economy is pastoral. They have much more pasture land than they themselves can use. Hence great numbers of beasts, largely sheep, with a sprinkling of goats, come into the country annually from Spain and France. Spain alone will rent privileges for 30,000 head. The revenue from the rents amounts to many thousands of pesetas each year. The least desirable lands and the most remote are allotted to the foreign animals. They are in the country from June 24, the fête of St. Jean, to September 28, the fête of St. Michel. Other than that the shepherds keep their flocks to the proper pastures and that they be out of the country by a definite date there is but one requirement. It may be demanded that for three nights the beasts be quartered on the higher fields for the sake of the manure. It is a common custom in the Pyrenees to quarter animals on fields at night, the smaller groups being enclosed in a movable stockade. Thus the animals are forced to cover the field systematically with droppings.

The migration of beasts has brought about the Spanish fairs of Le Seu on November 6 and Organya from November 27 to December 4. The French transhumants descend earlier, and there is a fair at Ax-les-Thermes on September 13 and 14. The fairs within Andorra are yet earlier, and it is interesting to note that the farther downstream, the later the date of the fair. Thus we have the fair at Encamp on September 10, at Andorra la Vieja on September 27, and at Sant Julia on October 5 and 6. The fair in Andorra la Vieja is the most important, as this is the date of the descent of the Spanish beasts. The animals are largely sheep; about one in twenty of the Spanish animals in 1927 were goats. Mares and mules and even pigs are turned upon the *pla*, but rarely the cattle. They find better herbage on the *comas*, and they will feed on terrain too wet underfoot for the sheep.

This aspect of herding involves only a small number of men. The French sheep are guarded by Frenchmen. The Spaniards are inclined to bunch their herds and turn them over to Andorran shepherds. These men live aloft for three to four months in a crude stone shelter with a single blanket against the night. The herds are always under the sky. If at first too cold, the sheep are driven to lower altitudes for the night. A certain number of the beasts are locally owned. The communes of Encamp and Canillo have little farm land and much *pla* pasture and own most of the 16,000 or 17,000 sheep of Andorra. The local people keep their goats in the villages the year around, so as to profit from the milk. A small amount of sheep's and goats' cheese is made at a definite period in the summer, the cheese being divided between the shepherd and the owner.

The second phase of the transhumance is the migration of beasts of the Andorran villages to the better and usually less distant pastures. This involves mostly beef cattle, mares, and their mule offspring. Andorra is too isolated for dairying, and in any case the tradition of the Pyrenees favors beef cattle rather than milch cows. The raising of mules is one of the chief sources of local income. These animals usually descend earlier than the other animals from the *pla*. They come down in time to profit from the grass growth on the valley meadows after the last cutting of the hay and to fertilize the fields before the autumn plowing. The hay of the valleys is not even sufficient for the winter stabling of all the Andorran beasts. The Andorrans frequently buy rights to pasture sheep in winter on Spanish farms as far south as Lérida.

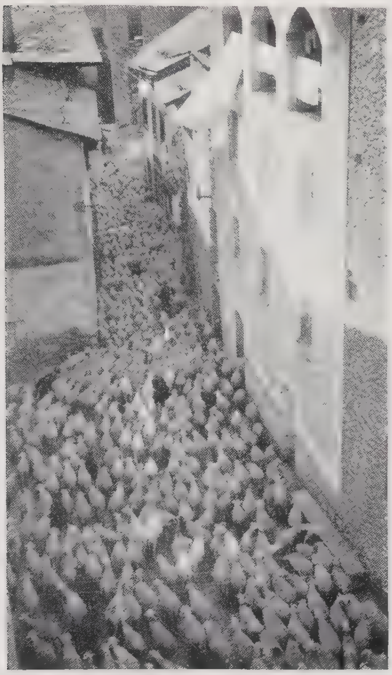

FIG. 9

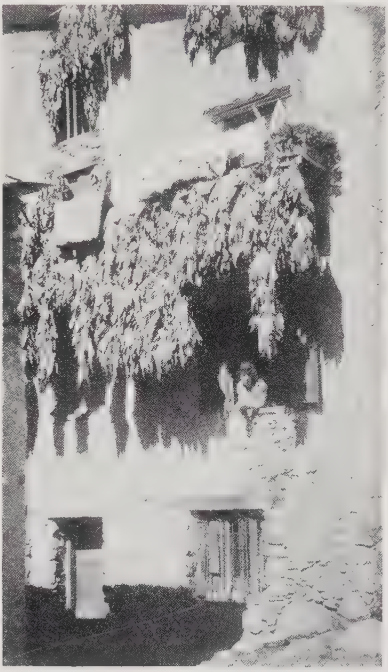

FIG. 10

FIG. 9—The sheep and goats from the Andorran uplands, migrating to Spanish plains for winter forage, come down through Escaldes a thousand at a time.

FIG. 10—One of the most characteristic sights of Andorran autumn is the tobacco hanging from the windows to dry.

INDUSTRY AND COMMUNICATION

There is so little industry and such poor communication that not much may be said of either. An exception in the past was the contraband industry and today is the lumbering industry. Brutails, writing in 1904, said that the contraband industry was the chief source of revenue. Rios, writing in 1920, says it is negligible. Some of the well-to-do men of the country today are, however, the smugglers of a few years ago. The government took half-hearted steps from time to time to reduce smuggling, but one imagines that such legislation was merely a diplomatic gesture. It is more than likely that mules and tobacco are still smuggled through the lonely ports of the frontier.

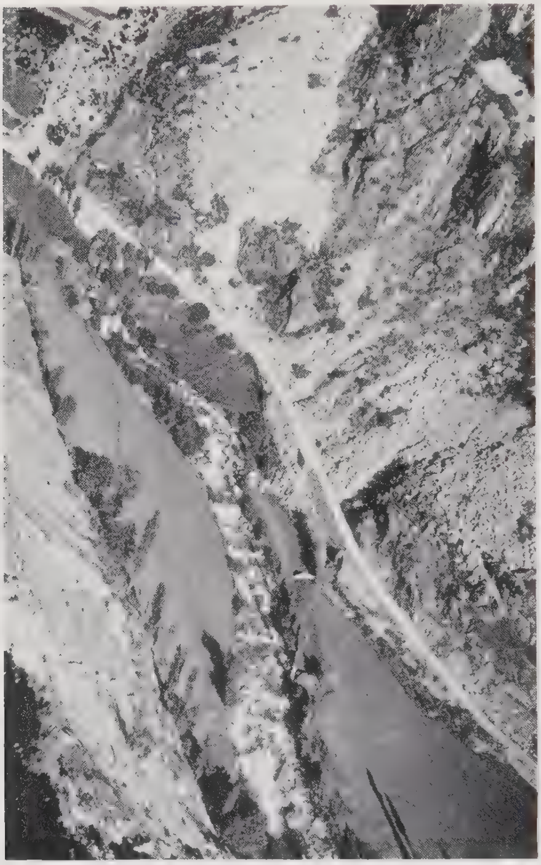

FIG. 11—Canyon agricultural land pictured from above at high noon. Most of the day such canyons have much shade. The narrow fields have a 45 per cent slope. The line of trees between the rock and the field to the left marks a canal, as do the lines in the field.

That Andorra was heavily forested at one time seems beyond doubt. The name of the country is reputed to have come from a Moorish word, *Aldarra*, meaning "place thick with trees." There are iron ores of value in the country, and a very heavy drain was put upon the timber by the early Catalan forges, whose numerous ruins are still to be seen. Today fuel wood is an important item, but lumbering is carried on in every permanent community. The construction of a sawmill is an easy matter, for there are power streams everywhere; and large quantities of logs are shipped out of Andorra la Vieja by motor trucks into Spain. The communes have complete freedom to cut in their forests. There is, I should judge, a greater subtraction of trees than is supplied by the annual increase. If this is so it is especially unfortunate, for water resources constitute the outstanding asset of the country, and the stream flow may well be damaged by future excessive deforestation.

The manufacturing industry is very slight. Cigarettes and cigars are produced there by a tobacco factory as well as by cottage industry. Matches for local use are made. There is a factory at Escaldes for woolen blankets and scarfs, chiefly for Andorran use as wraps and capes. Escaldes has four inns, three of them of good size, which have flourished because of the curative properties of the local hot springs. The country has a modest summer tourist season, supported by Catalans from Barcelona. There are in all the villages primitive but decent inns; even in the remote villages hostelries flourished in the days when smugglers might be beleaguered en route to France.

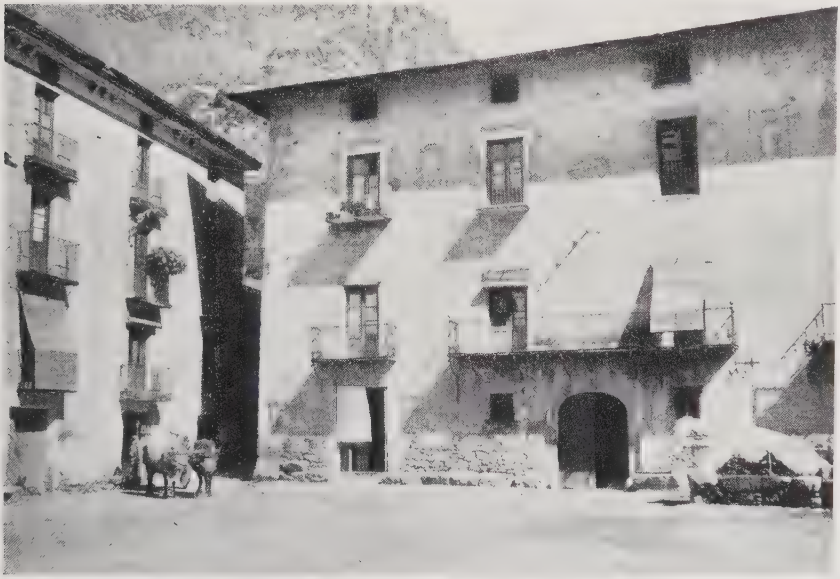

FIG. 12—The central square in Andorra la Vieja is deserted under a noon sun. The clear-cut shadows, the Spanish awnings, the ever-flowing fountain, and a mountain for a background are all typical of the country

The industrial future of Andorra lies in its iron ores, there being deposits in the region of Ransol, at Port Negre, the Coma of Claro, near the Pic de la Mariana, and in the valley of Ordino. I examined the first deposits. They were largely hematite with some brown limonite and carbonate ores. The deposit which outcrops prominently on the valley wall appeared to be important and could be obtained, at first at least, by quarrying.[10] In the fall of 1927 a franchise for exploitation of iron ores was granted to a French syndicate. This involves the building of a road out of the Ordino Valley into France, perhaps by a pass 2546 meters above sea level. There was a time when it seemed as if a Spanish syndicate were to have the franchise; but at the last moment it was found that the Spaniards had inserted in the agreement a clause giving them the right to levy toll on all automobiles using the roads which they were to construct. The Andorrans were indignant: no one should ever levy tolls upon Andorra. The Spaniards were thrown out. The tradition of independence was maintained.

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[10] For the composition of the ores see Marcel Chevalier, *op. cit.*

Andorra has two roads. One, a fine and much used highway built by Spain through the good offices of the Bishop of Urgel, runs from Seo d'Urgel past Sant Julia and Santa Colomba to Andorra la Vieja and has been recently continued to Escaldes and Encamp. Immediately upon proceeding beyond Encamp one is forced to climb a difficult mountain side through a chaos. It is little wonder that engineering difficulties here baffled further road construction. France has built a post road from L'Hospitalet (1436 meters) to Soldeu (1825 meters) over the Port d'Envalira at 2407 meters altitude. The postman does the route from Soldeu to Andorra daily on foot unless the weather is too inclement. The round trip takes about eight hours. From Andorra to Seo d'Urgel one travels by motor bus in an hour. Both France and Spain maintain telegraph systems in Andorra as well as postal systems. In the last year Andorra has instituted its own postal service. The country has had no money for public improvements, the taxes being merely a poll tax. No public official is paid a salary. No army or formal police force is maintained. The schools, Catalan and French, are supported by those who use them. The Spanish schools are supported by the Church. The ancient bridges, mule paths, the house of government—known as the Casa del Vall and perhaps as quaint a national monument as you will find—have had little care. The routes out of the country, other than those mentioned, are wild mountain trails developed by the smugglers and not overadvertised. The length of these routes to the outside world is eight to twelve hours, the true way of measuring mountain distances.

Quality of Life

The real Andorra is not easily discovered. Ordinarily a traveler sees only the permanent villages, which are not unlike other Catalan villages in France or Spain both in appearance and organization of life.

Villages such as Sant Julia, Andorra la Vieja, and Escaldes are in fine valleys, on a highway, and have a brisk trade. There one finds automobiles and farm machinery. There is plenty of food, and health and happiness abound. But life in Andorra can be very meager and primitive.

The most characteristic element in Andorran life lies in the high villages or in the little-visited hinterland, the *pla* country. The high villages, or *cortals*, are the equivalents of the *mayen* communities of the Swiss. They are situated on the lowest *alp*, or *mayen*, on a line between the highest fields and the lowest limits of high-level pastures.

Thus the fields benefit from the manure deposits. There are in addition *bordes*, or isolated houses, frequently at higher elevations than the *cortals*. The *cortal* of Lo Serrat is at 1560 meters. The *bordes* of Encamp are at 2008 meters. The zone of precarious agriculture is between 1600 and 1850 meters. Above that are wild prairies, hence the *bordes*. The highest permanent habitations are at Soldeu at 1825 meters. In 1897 when there were 5210 persons in the country, there were 1042 houses.

There is a regular and characteristic sequence of seasonal migrations. When the cattle mount in the spring, the entire family may go to the temporary village to herd, mow, and plant. With the descent of the cattle in autumn, the temporary villages are again inhabited. Harvests are made, fields are manured, and plowing is done. Again in midwinter certain families may return to these villages with the cattle to profit from the hay stored there at a time when the hay in the lower granges is exhausted. Christmas is frequently celebrated in these high-level homes. The time which the family may spend in the temporary villages may be hardly less than that spent in the permanent villages. The differences between them lie in the size and number of the houses, the furnishings, and the unkempt nature of the higher houses. Essentially the upper villages are storage depots for hay and manure.

Changes, however, are coming fast. Roads now enter Andorra from two sides. Economic independence is giving way before a changing and improved economy and a growing import and export trade. This trade is more Spanish than French; indeed, because of the low-level route to Spain and the proximity of an active city there, Seo d'Urgel, Andorra has always been more Spanish in culture than French. There are two electric light plants in the country; it was something of a shock to find the woman in the primitive *fonda* at Soldeu abandoning her hearth cookery for that of electricity. The national costumes are no longer seen. At the fêtes modern instruments have replaced the bagpipe and flute. The Charleston is danced on the streets. There was opened in 1928 a trans-Pyrenean railway which skirts the border of the little country. But there will always be individuality to Andorra. A mountain is always a mountain, a mountaineer always a mountaineer, and the country still holds its rustic mountain peace.

AN EXPEDITION TO THE CENTRAL ANDES
1926 to 1928

Karl Troll
University of Munich

IN 1926, thanks to the aid of several German authorities and institutions, I was able to set out on an expedition to the Central Andes, an expedition which in the first place had for its object investigations in glacial and in botanical geography. By favorable circumstances I was enabled to extend the journeys and researches over more than two years and thus to place the whole enterprise on a much broader geographical basis. The territory covered extends from the 23rd degree of latitude on the Argentine-Bolivian border approximately to the northern end of the Titicaca plateau and from the Pacific coast to the Gran Chaco and the edge of the Amazon basin (see Fig. 1).

My preliminary studies in Europe pertaining to biological and botanical geography, to morphology and glaciology, as well as to questions of agricultural geography enabled me to dispense with the help of scientific collaborators and thus gave me the advantage of being entirely free and independent: at the conclusion, however, I had occasion to work four months, May to August, 1928, within the organization of a larger expedition, the Andean Expedition of the German-Austrian Alpine Society, whose purpose was the opening up of the Cordillera Real to alpine sport.

The first problem of the glaciological investigations was the shifting of the climatic zones during the Ice Age, which was to be specially tested on the plateau area of interior drainage. In order to elucidate this question it was necessary to make researches into the geological history, establishing therein some new divisions. Thus the problem proved to be a very extensive one, at best promising solution only in rough outlines.

In the realm of botanical geography we have at our disposal the fundamental works of Theodor Herzog on the vegetation of central Bolivia, which with their accurate floristic and geographical data have raised a great many new questions. These researches have been continued through the vast still unexplored regions of the Altiplano, the Western Cordillera, the northeastern slope, the Río Grande and Pilcomayo, so that a complete vegetation map of the whole Central Andes is now under preparation. The new researches on vegetation are based on a collection which comprises nearly 4000 specimens.

Based on these researches are the agricultural studies which envisage a system of agricultural geography, contemplating not only the productivity but also the economic aspect, degree of civilization, relations to social and geopolitical questions, systems of crop rotation, reciprocal relations between agriculture and cattle raising, etc.

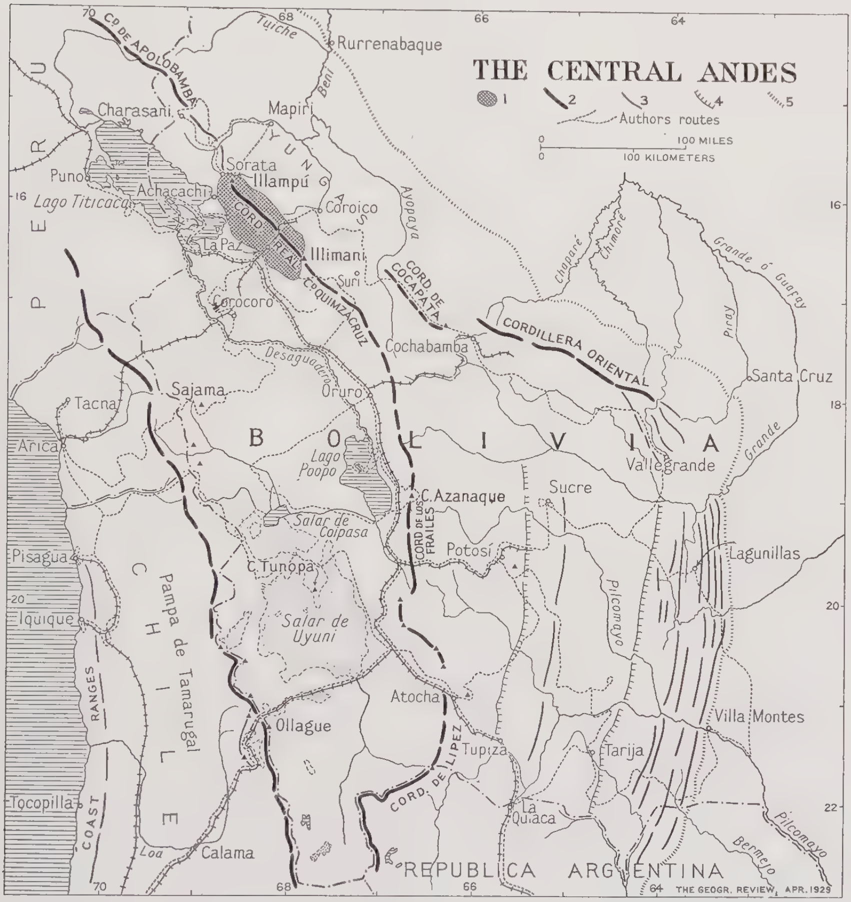

FIG. 1—Map showing the author's routes in the Central Andes. 1, area surveyed in detail; 2, main ranges of the Andes; 3, lesser ranges; 4, eastern border of Puna blocks; 5, eastern border of Andes. Scale 1 : 8,250,000.

CORRECTIONS TO THE MAP

In view of the low standard of the cartographical information about the country, particular care had to be devoted to mapping. The routes of the journeys, which aggregate some 12,000 kilometers, were established for the most part on the maps and, as far as the scientific questions allowed, were chosen to cover new territory. From such journeys it was revealed that our knowledge of many sections was wholly erroneous, not only our topographical conceptions, but also our knowledge of places. In one part of the territory visited I had the advantage of using as a base for my studies our present knowledge in the condensed form in which it appears on the La Paz and Puno-Río Beni sheets of the Millionth Map of Hispanic America, published by the American Geographical Society. It was astonishing what fundamental changes had to be made even on these sheets which were carefully compiled from all data in existence, as the following corrections instance:

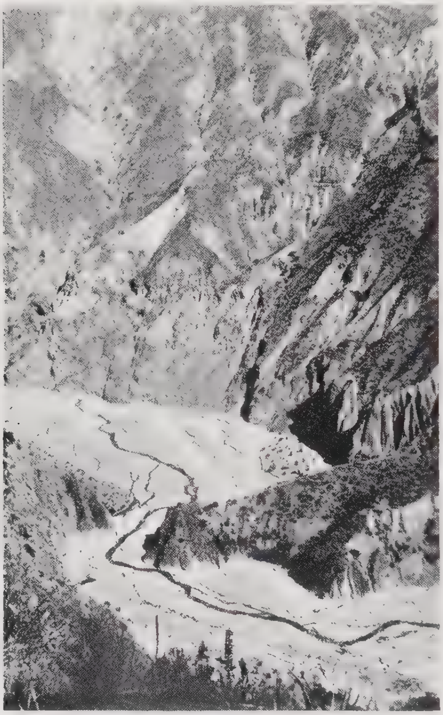
FIG. 2—The dry canyon of the Palca River, affluent of the La Paz River.

1. Near Sorata, between the Cordillera Real and the Cordillera de Apolobamba, the Eastern Cordillera is not interrupted but only slightly depressed. It extends continuously over Tacacoma, Ayata, and Amarete with peak altitudes of 5000 to 5200 meters, but its representation is entirely missing on all present maps.

2. On the eastern shore of the Salar de Uyuni the Cerro de Tunopa has to be completely canceled, for it is identical with the Cerro de Tahua on the northern shore. In its place, and instead of the pampas joining in the south, there is a hilly country with a pronounced chain structure.

3. The principal part of the Cordillera de los Frailes, a mountain range stretching from north to south (south of the Río Mulatos-Potosí Railroad) with a crest that attains more than 5000 meters, is missing on the present maps.

4. The whole province of Ayopaya, situated between the Cordillera de Quimsa Cruz and the Cordillera de Cocapata and shown as unsurveyed in the La Paz sheet, must be totally remapped both as to location, river system, and settlements, as well as to the structure of the mountains.

Detailed topographic surveying was carried out with photogrammetrical equipment in the surroundings of La Paz and in the Cordillera Real, especially in the latter zone by the alpinist expedition. The Cordillera was triangulated as a whole, and its most important and interesting sections were also surveyed by means of photogrammetry.

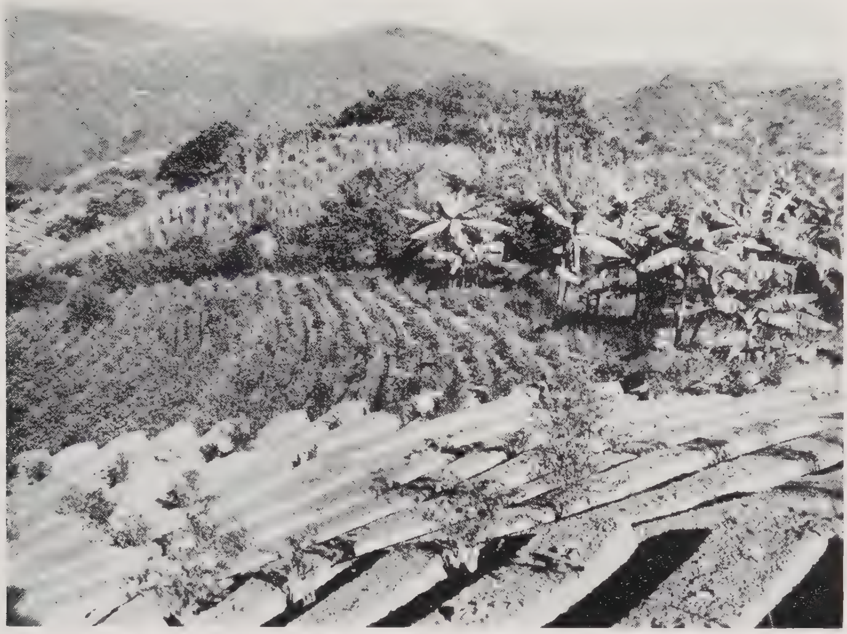

FIG. 3

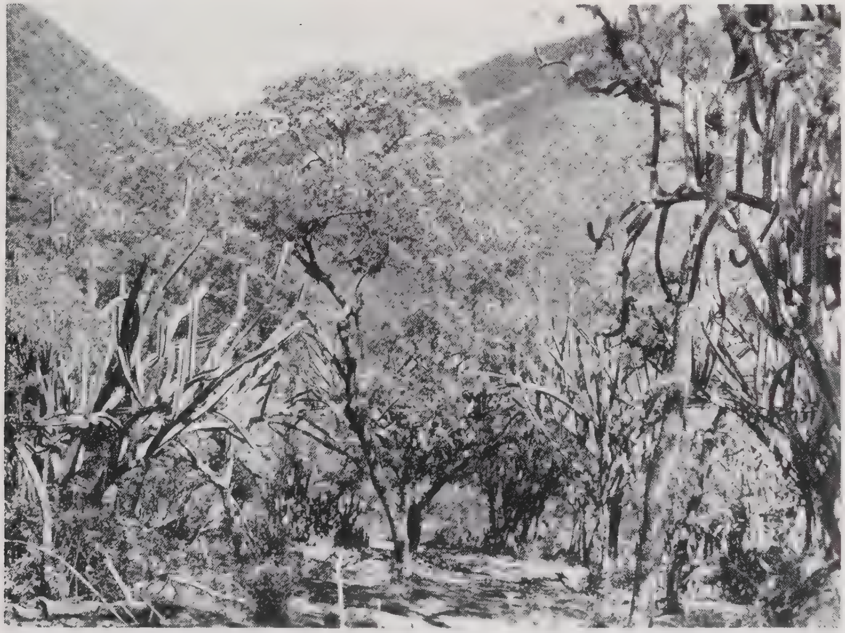

FIG. 4

FIG. 3—Agriculture in the Yungas zone. In the foreground old and new plantations of coca in terraces, in the middle ground plantation of rice and bananas.

FIG. 4—Dry wood vegetation of the Sacambaya Valley (province of Ayopayo) with quebracho (Schinopsis) and great cactus (Ulala).

THE EASTERN CORDILLERA AND THE MAPIRI REGION

The first journey was into the Cordillera Real and the Cordillera Quimsa Cruz, their glacial foreland in the region of La Paz, as well as the gorge of the La Paz River through the Cordillera. The diluvial sediments were divided in two principal groups, ancient and recent detrital deposits, which near La Paz are separated by a zone of volcanic tufa. The recent detrital deposits constitute, in the shape of a complete glacial series, the superficial covering of the Altiplano, deeply cut by the erosional valley of the La Paz River. Both the volcanic tufa and the vertebrate fossils of the ancient diluvial formation discovered by Professor A. Posnansky are of importance for further age determinations. The first trip was to the shores and islands of Lake Titicaca, and it proved possible to ascribe to one and the same age the ancient high lake level and the ancient detrital formation of La Paz and also the glacial deposits of the Cordillera Real in the region of the Quecahahuira near Achacachi.

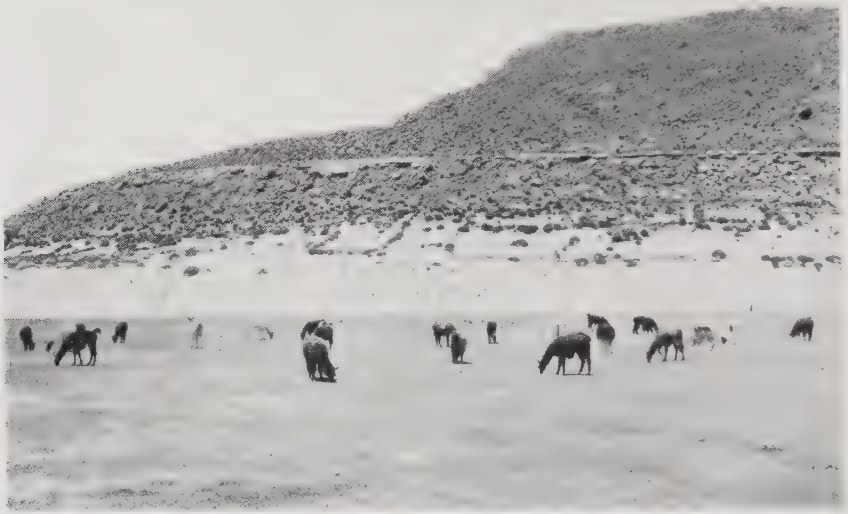

FIG. 5—The old shore line of the ancient Lake Minchin at the Aullagas hill near Lake Poopó: white line of calcareous tufas, at the foot of the hill recent sand dunes.

The second journey led through the apparent gap between the Cordillera Real and the Cordillera de Apolobamba into the tropical rubber region of Mapiri and back through the province of Muñecas. This trip was a success in many respects. The Cordillera was visited from Sorata to Charasani, where in several places it is cut by deep gorges similar to that of the La Paz River. These depressions in the crest of the Cordillera (to nearly 5000 meters) imply that the climatic divide corresponds not with the mountain axis but with the water divide. In the deep valleys themselves, as in the La Paz gorge, an extremely arid climate is encountered, further characterized by singular periodical winds. The humid heights are covered with a belt of clouds, and cloud forest covers them also, with arid valleys below, following a climatic and vegetational law which applies to all deeply indented valleys at the forest limit of eastern Bolivia and produces unrivaled contrasts of vegetation. In the region of Mapiri the first indications of Pleistocene uplift were seen on the edge of the mountains in eastern Bolivia in the shape of wide gravel sheets, which lie at 400 meters above the valley bottoms.

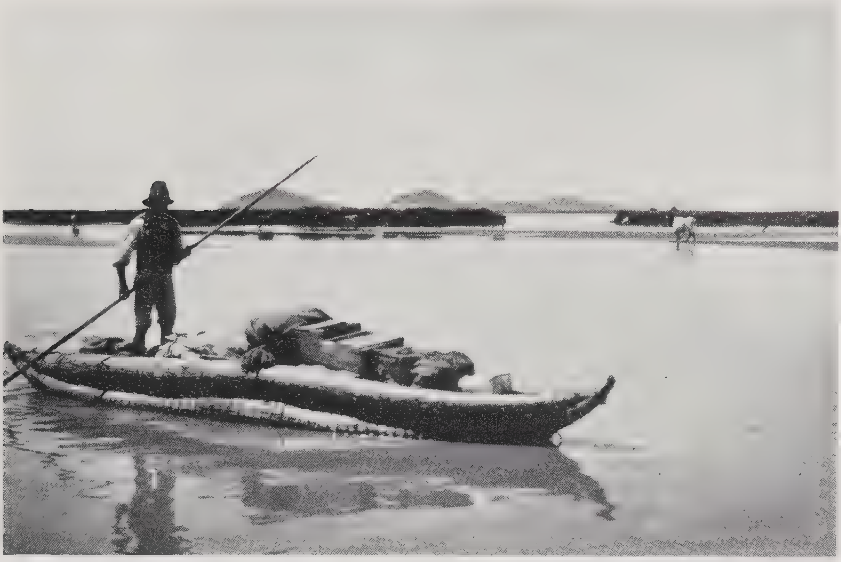

FIG. 6—The new course of the Desaguadero River above its discharge into Lake Poopó.

THE DESAGUADERO RIVER

During November and December, 1926, I took part in a journey down the Desaguadero River, organized by Professor Posnansky, from Lake Titicaca to Lake Poopó, which promised me a solution of the glacial problems of the Altiplano, following the former studies of Isaiah Bowman on the same river. The difference of age, recognized by Bowman, between the northern and southern lakes of the Altiplano—named by him Lake Ballivián and Lake Minchín respectively—was confirmed: the southern lake near Challapata, which is situated on Lake Poopó, could be correlated with the more recent glacial deposits of the Azanaque Mountains. It is true I did not find the southern end of the northern lake near the Fairweather Gap, so named by Bowman, but much more to the south. The

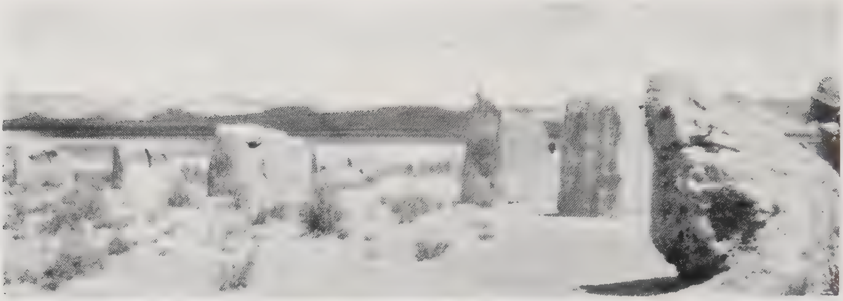

FIG. 7—A chulpa village between Ulloma and Callapo (Desaguadero River).

vertebrate deposits of Ulloma, completed by new discoveries made on the Desaguadero below Nazacara, proved to be of the same age as Lake Ballivián and the ancient diluvial formation.

An unexpected discovery was a modern shifting of the lower course of the Desaguadero. It occurred in 1922 and involved a lateral displacement of 12 kilometers over a distance of 30 kilometers. It was a consequence of a two-meter rise in the level of Lake Poopó during the last 20 years, since the survey made by Neveu-Lemaire, a rise which became manifest by the depth measurements, by inundated land vegetation, and by the disappearance of islets. From Lake Poopó I traveled by land, following the Lacahahuira, the still unexplored drain of Lake Poopó, through the south of Carangas to the Salar of Coipasa and to the Chipaya Indians, the unique vestige of the primitive population of the Altiplano, who, though only 200 to 300 in number, have completely preserved their own language, habits, and purity of race. Together with the already half-amalgamated Urus of the Desaguadero they belong to the large family of the Aruacos.

ACROSS THE ALTIPLANO

Another trip, which lasted three months, led from La Paz right across the Altiplano, where complementary observations were to be made regarding the glacial problem, through the Western Cordillera,

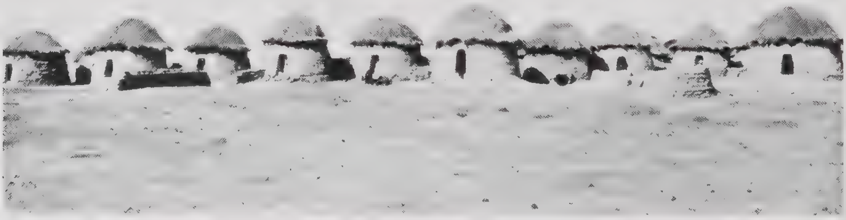

FIG. 8—The round thatched huts of the Chipaya Indians near the Salar of Coipasa.

down into the West Coast desert at Tacna, through the nitrate section, and back over the southern part of the Altiplano (province of Lípez) into the valleys of the upper Pilcomayo system to Potosí. On the outward journey the Western Cordillera was crossed in its highest and widest part, in the Sajama section, on the return near the borax lake of Chilcaya, where the outer slope to the desert still carries a pronounced marginal character, as to climate and vegetation. The most remarkable sight in the visited section of the Western Cordillera is the vast *queñuales*, Polylepis groves, which grow at between 4200 and 4500 meters altitude on all mountain slopes. On the coast, the signs of recent uplift were examined in their relation to the accumulation of the large desert table-lands. On the trip over the southern Altiplano the extension of Lake Minchín was traced so far that a rather detailed map of it can be drawn.

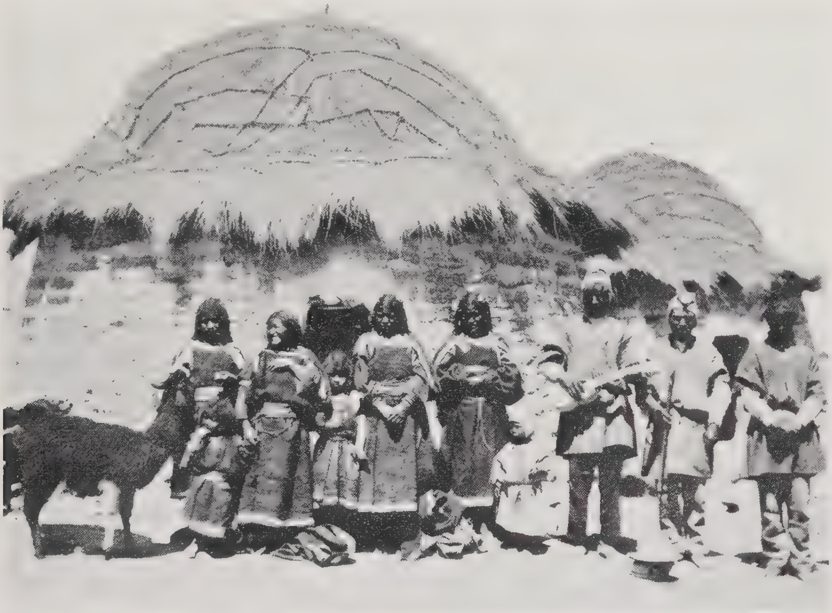

FIG. 9—Chipaya Indians in their original costume

On the eastern slope, indications of a post-Tertiary uplift were first noticed in the provinces of Chichas. From the region of La Quiaca on the Argentine border, a strikingly low region stretches in the longitudinal direction of the range as far as and beyond Sucre, which I have named the Chichas-Chuquisaca Depression. In it diluvial gravel sheets lie high above the rivers (400 to 500 meters) and rise eastward still higher over the valley bottoms. They, too, carry vertebrate fossils like the ancient diluvial strata of the Desaguadero, indicating, as do the high lying gravel sheets of Mapiri,

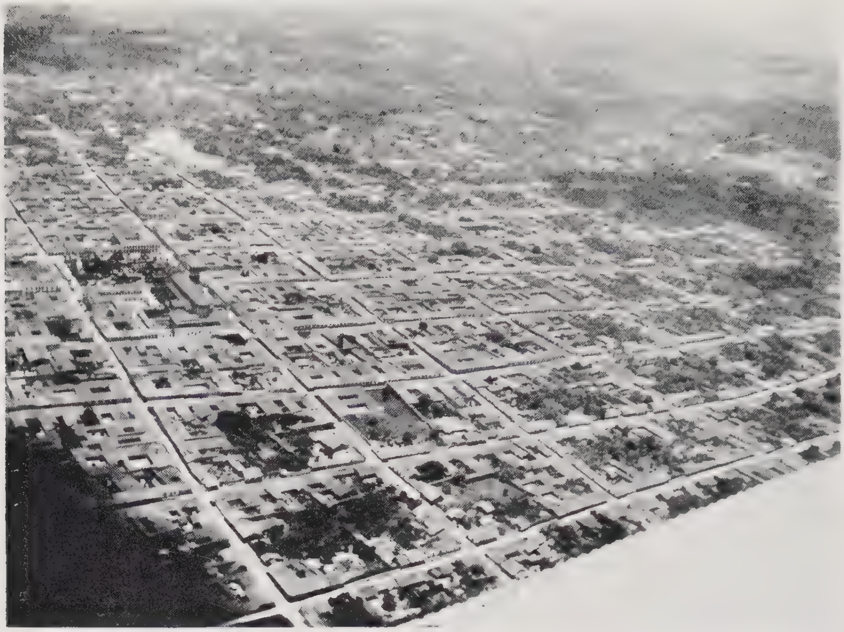

FIG. 10

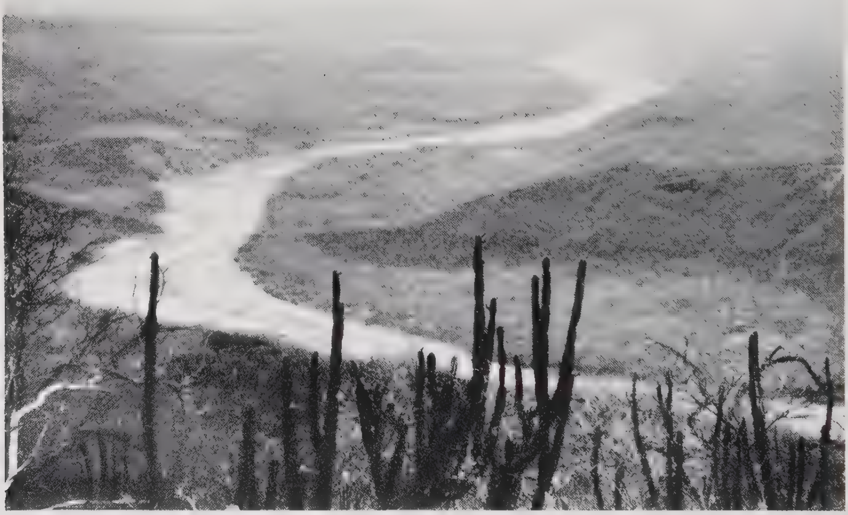

FIG. 11

FIG. 10—An aerial view of Santa Cruz de la Sierra.

FIG. 11—The outlet of the Pilcomayo River into the Gran Chaco. In the background the cleared land of Villa Montes.

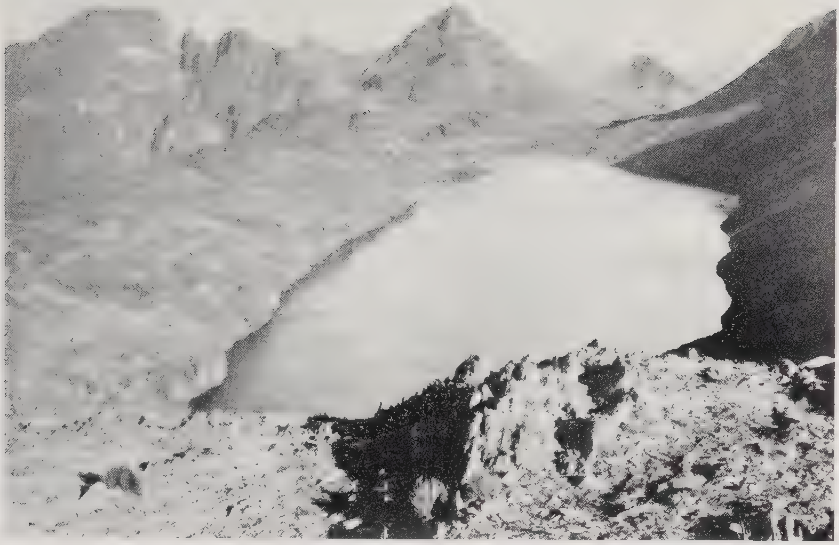

FIG. 12

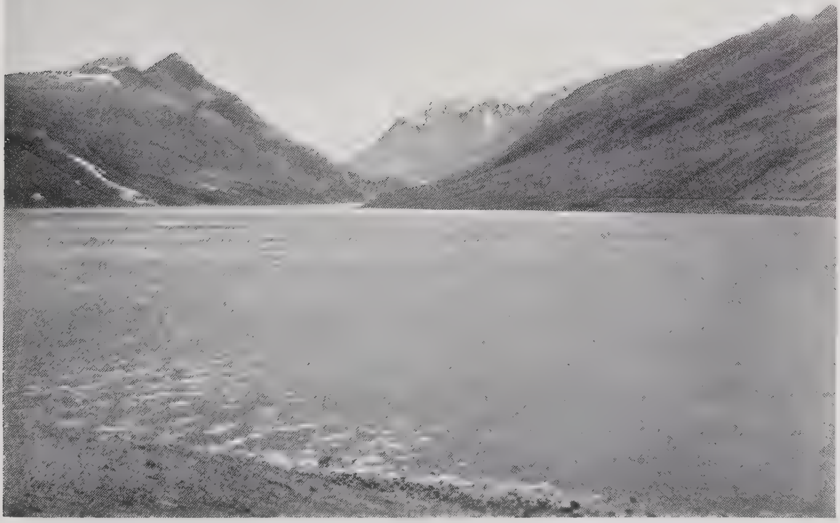

FIG. 13

FIG. 12—The glacial lake Tolcacota in the Cordillera of Muñecas near Amarete. The peaks are about 5000 meters.

FIG. 13—The moraine-dammed Aichucota Lake, Cordillera Real.

a rising of the mountains. In order to trace these gravel sheets eastward, I undertook another extended trip, examining the southwestern sections of the Andes from the Argentine border to the latitude of La Paz, for which the works of Oscar Schmieder provided a valuable basis.

Cross Sections to the Eastern Plains

The journey, from August, 1927 to March, 1928, consisted of four cross sections through the Eastern mountains to the Gran Chaco and the savana of Santa Cruz, then a course paralleling the northeastern slope of the Eastern Cordillera to the latitude of La Paz, the region of the Yungas. From Potosí and Sucre the way led through the province of Cinti to Tarija, where between the valleys of Cinti, Pilcomayo, and Pilaya I found the high closed basin of Culpina; from Tarija to the Argentine border near La Quiaca; and through the woodlands on the upper Bermejo. North of the Pilcomayo I proceeded into the Chaco. This was in the dry season, but I only reached the border of the hilly country against the plain properly so-called. The way back to Sucre and the second descent to the lowlands, over the Río Grande and Valle Grande to Santa Cruz, led through the northern continuation of the regions I had already crossed on the Bermejo; but this continuation was, from a botanical point of view, wholly unknown. It was important furthermore because it provided connection between the regions explored by Herzog and K. Fiebrig.

The transition from the humid land vegetation of the eastern edge of the Andes and the intermontane type occurs here, so to speak, in two steps. The first step coincides with the steep slope from the Puna to the outer border of the mountain chains, where the continuous humid forests of the border are limited by a belt of Podocarpus, Alnus, and Myrtaceae. Thence follows first a band, of varying width, of grassland with scattered groves of the aforementioned trees and heathlike bush formations. A second sharp border line marks the step to the continental Puna formations, in a line that goes from Cuesta de Sama near Tarija over the Cordillera de Sombreros to Cerro de Achachi. The vegetation of the free and open heights is in absolute contrast with that of the deep valleys. In these, as in northern Bolivia, great drought and warmth prevail, increasing eastward with the lowering of the valley bottom and presenting yet more abrupt transition with the moist forests of the east. In the Río Grande region these dry valley formations are much more widely displayed than in the Pilcomayo, where they occupy only narrow ravines. But at the same time in the north, at the high elevations, the humid grasslands and groves penetrate far into the mountains.

Rich in surprises was the journey through the province of Ayopaya. Only hydrographically does it belong to the Yungas zone, inasmuch as its numerous valleys unite in the Río Ayopaya, which flows to the Beni system. As regards climate and vegetation it constitutes a kind of interandean basin, not penetrated by the forests and the climate of Yungas. The subtropical *ceja* forests, which cover the northeastern length of the Cordillera de Quimsa Cruz, extend only as far as the water divide between the La Paz and Ayopaya rivers. In Ayopaya all the valleys are dry, resembling those of southeastern Bolivia (Pilcomayo, Río Grande, etc.); and, as there, above the dry forests of the lowlands (quebracho forests), the moist meadows and groves extend farther into the mountains, so here also humid grasslands and mixed forests of Podocarpus, Alnus, and Myrtaceae dominate the altitudes. Thus it may be said that botanically and generally physiographically, Ayopaya belongs not to northeastern but to southeastern Bolivia.

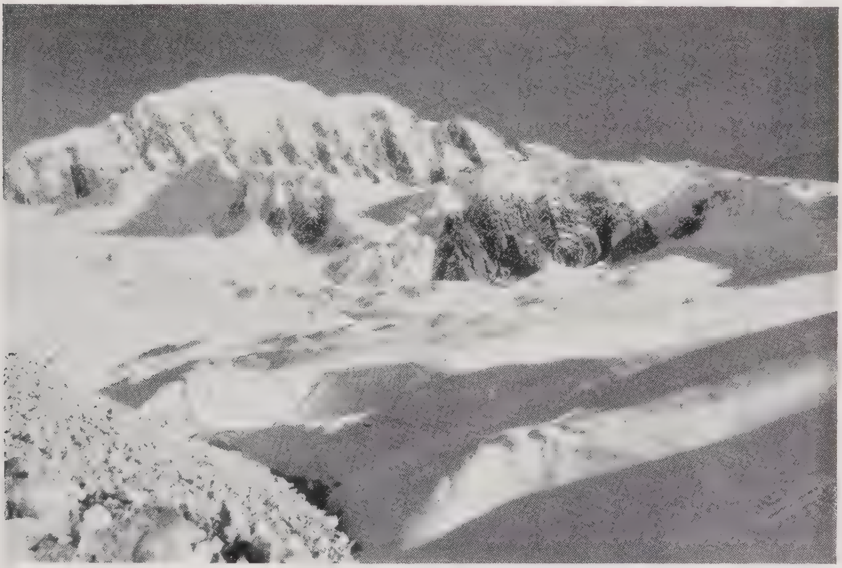

FIG. 14—Illampu peak from the east, Cordillera Real.

THE YUNGAS

The last part of the journey was to the Yungas, and especially to the Yungas in its narrow sense, the Yungas of Inquisivi and La Paz. The restriction of the term "Yungas" to these provinces, in accordance with the local conception, has a certain justification. For only the provinces of North Yungas, South Yungas, and Inquisivi have been capable of continuous and dense settlement in connection with an intensive agriculture, the principal crops being coca and coffee. Nor is it by chance that such settlements have arisen just there. The botanical mapping has proved that the section of the Yungas which today is well populated and cultivated was not naturally woodland like the zone of the "subandean woodlands" as a whole, which from a geographical standpoint are called Yungas, but half-open lands, a kind of savana, i.e. *pajonales* with interspersed trees and bushes. This "island" of open formation forms a zone running with the mountains from southeast to northwest and crossing the Yungas valleys, containing the chief settlements of Suri, Cajuata, Circuata, Irupana, Ocobaya, Chulumani, Coripata, Arapata, and Coroico as though they were strung on a chain. The zone corresponds to a depression in the mountains, a depression which seems to be characterized by a drier climate. So, also, we can explain two offshoots of this open cultivated zone towards the west, which follow the two deep valleys of Tamampaya and Coroico but strictly speaking are developed only on the sunny, northerly exposed valley slopes, with the chief settlements of Chirca, Villa Aspiazu, Yanacachi, Huancané, and Sandillani.

The Cordillera Real Again

In April, 1928 I joined in La Paz the Andean expedition of the German-Austrian Alpine Society, with which I passed the months of May, June, and July in the High Cordillera (Cordillera Real). The scientific work done here was founded upon that preceding. The chief feature was a topographical survey of the Cordillera, which for its display of magnitude perhaps represents the mightiest of the whole Andean system. Probably only the Cordillera Blanca of northern Peru and the Cordillera of the Chilean-Argentine border compare with it. The survey comprises a triangulation from La Paz to Sorata, including all the Cordilleran peaks, an accurate topographical elaboration of the region of Ancohuma and Illampu, that of Huayna-Potosí and Condoriri, and the valley bowl of La Paz. All the other items are added to this network of triangulation by means of detailed sketches. The new map provides a picture which deviates essentially from the present conceptions and even from the special representation by Conway. For instance, the structure of the highest mountain massif in Ancohuma and Illampu has been completely changed; the northeastern slope shows several spurs, more than 5000 meters high, which advance towards the Yungas zone and contain, amongst other features, the newly discovered Tiquimani body (5800 meters). The slope to the Altiplano also is highly articulated by a system of far-penetrating valleys, where I found, besides the moraine-dammed lakes already known, a series of new ones. More important than the detailed articulation of the mountain is its location at the great divide between the spheres of influence of the Atlantic and central plateau climates. The sudden drop of the ridge from Illampu by more than 1000 meters to the Cordillera de Chuchu is recognized as a tectonic phenomenon. The granitic batholith which forms the nucleus of the mountain is proved to be both complicated in structure and asymmetrical, occupying a large area in the east—to within the woodlands, whereas on the west it scarcely extends beyond the crest of the Cordillera.

Here the glaciological studies were consummated. I finally succeeded in explaining former inconsistencies in the Pleistocene physiography of the region. The recent glacial period of the present classification has to be divided again into two separate ice epochs. The great gravel sheets which form the Alto de La Paz belong to the penultimate glacial epoch; the terrace on which the principal part of the city of La Paz itself lies belongs to the last glacial epoch; but the formation of the valley bowl of La Paz dates from the interglacial epoch. Compared with European alpine conditions, these two last glacial epochs thus correspond to the Würm and Riss glacial epochs; and the period previously called ancient glacial, which is separated from the more recent one by the great interglacial epoch, must be referred provisionally to the Mindel and Gunz glacial epochs. To it belong the large vertebrate deposits of the Desaguadero, as well as the smaller ones near La Paz, on the Pilcomayo, and at least the more recent strata in the basin of Tarija.

AGRICULTURAL ADAPTATION IN BOLIVIA

Eduardo Romecin

THE government of Bolivia proposes definitely to abandon, for the present, intensive official attempts at actual colonization of the eastern frontier regions and to confine its main efforts toward increasing the agricultural production of those areas of the country that are now under cultivation. In the past, schemes for the colonization of eastern Bolivia have been advanced by many political leaders. The government has fostered many such projects, freely granting land for the purpose. Settlers, lured by the prospect of fortunes easily won from the rich agricultural resources, have not been lacking; but, without exception, these attempts at colonization have failed. Potentially rich the region is, but to turn its potentialities into actualities is quite another matter. Lack of capital to clear the land and buy seed and implements has played its part in the recurring failures. Nor is the effect of tropical diseases, with which the colonists had had no experience and against which no effective means of resistance were provided, to be discounted. The chief cause of failure, however, has been the complete lack of transportation facilities and, as a result, absolute inability to get the products of the farm to market.

The government now believes that these pioneer areas should be reserved for the future when the population of the country shall have increased to a number which the present cultivated areas cannot support even though developed to their maximum capacity, when the actual need of raw materials will drive men to seek new lands. However, when that time comes these frontier regions will not be new lands in the sense that their possibilities are unknown. It is the present purpose to study them thoroughly, to appraise their resources, to work out the best methods of settlement so that, when the time for colonization comes, it can be accomplished without waste of life and capital; and to plan for the development of each section according to the agricultural activities best suited to it. It is believed that colonization of the frontier when it is undertaken must be on a large scale with provision for broad communal organization if the great physical obstacles that have defeated all prior attempts are to be overcome. Meanwhile companies with large capital will be allowed to study particular areas and create settlements under scientific principles. Aside from such individual efforts, however, it is the purpose of the government to foster the agricultural development of the country as a whole.

Agricultural Classes of Bolivia: the "Colonos"

Four classes make up the agricultural life of Bolivia: the community Indians;[1] white landed proprietors who usually live in the towns and visit their *haciendas* only at sowing and harvest time; the *mayordomos*, usually of mixed blood, who operate the *haciendas* under authority from the owners; and the *colonos*, or peons. To these may be added limited groups of Indians and others who now have small holdings of their own. The community Indians, except as they are subject to the laws and traditions that govern their communal life, are independent. The communal holdings are usually in the more isolated districts, and methods of cultivation are most primitive; but the community Indians, by virtue of their independence, are able to add to their earnings by fishing, carrying, or hiring out in the mines, according to the locality in which they live. They seem contented with their lot and do not enter into the present agrarian problem.

The *colonos* constitute the largest agricultural class. It is frequently stated that the *colonos* are bound to the *haciendas* to which they are attached. If they are bound it is by their own traditions and not by any law of the land. It would, perhaps, be more accurate to say that the owners of the *haciendas* are bound to the *colonos*, since the *colonos* on any particular estate are so attached to it and so jealous of their traditional rights and privileges on it that it is almost impossible for the owner to dislodge any of them even if he desires to do so. The relations of the owner and the *colono* are, however, regulated by law. The *colono* must give to the owner a certain amount of service—mostly in the cultivation of the owner's land. He receives in return a plot of land for his own use usually consisting of about one and three-quarters acres. These plots are realloted from time to time in accordance with a system of crop rotation that applies to the whole *hacienda*. They are generally so distributed that each *colono* has a parcel of land suitable for various crops and for pasture for his alpacas, llamas, sheep, and the oxen with which he works his own allotment and the owner's land.

It is with the Highland Indians, and with the *colono* class in the first instance, that the present plan of colonization has to do. Bolivia desires European colonists but realizes that her first duty, as well as her practical duty from the standpoint of national well-being, is to improve the condition of that class of agriculturists that forms the larger part of her population. Since time immemorial these Highland Indians have farmed the Altiplano and the more temperate valleys of the eastern ranges of the Andes. They love the land. They are adapted to the region. They have an inherited system of coöperative farming. They are a hard-working people and, under organized leadership, work efficiently. Whatever policy the government adopts must give first consideration to their needs and their capacities. It is with these people that colonization must begin.

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[1] Compare G. M. McBride: The Agrarian Indian Communities of Highland Bolivia, *Amer. Geogr. Soc. Research Ser. No. 5*, 1921.

Colonization, in this sense, has quite a different definition from that usually accepted. It does not mean the seeking of new farm lands in unsettled territory. It means the utilization to their maximum productivity of all of the farm areas now under cultivation—on the allotments of the *colonos* in order that, with greater acreage returns, their standards of living may be elevated; on the owners' land in order that it may be possible to release larger allotments to the *colonos* or, perhaps, free land that may be sold to him. More efficient methods and the use of modern machinery will increase the acreage that can be handled by the individual *colono*. The ultimate result expected is increase in the number of independent landowners and increase in farm products for feeding the urban and mining population. It is believed that, under methods of cultivation of the highest possible efficiency, the present population will not be sufficient to till the soil and harvest the crops and that room will therefore be provided for European colonists on the more temperate lands for which they are better adapted rather than in the tropical or subtropical regions of the Oriente of which they have no experience. All of these areas lie near centers of population; most of them are near transportation routes actual or feasible.

Problem of the Cochabamba Valley

There can be no doubt of the desire of the Highland Indian to possess land of his own. Proof of it is seen in the land boom at Cochabamba that followed the completion of the railroad from Oruro to Cochabamba in 1916. Prices of land in the Cochabamba Valley rose in some cases to as high as $2000 (U. S. currency) an acre, and even at such prices there was not sufficient land available to supply the demand. The reason for this great rise in land value was twofold: first, the normal effect of large numbers of prospective buyers; and, second, the characteristic attitude of the white landowners of holding out against selling land to Indians. The cause of the boom, itself, was the prospect of a railway route by which farm products could be shipped directly to the mining districts of Oruro and Potosí and the towns and cities of the Altiplano. These prospects, however, were not fulfilled because the exorbitant shipping rates demanded by the railroad ate up the profits, so that there was nothing left to pay on the obligations incurred in the purchase of the land. The result has been heavy mortgages and general depression. The railroad has now been extended to Cliza, but there has been no land boom there.

The problem of the Cochabamba Valley is a difficult one. It involves both reduction in railway rates to a point where the valley farms can profitably raise and ship their products to the market and assistance to the farmer in getting land at reasonable prices. It is probable that the government must, in the first instance, confine its efforts to helping those farmers who are in the possession of land to a more efficient handling of it. This will bring about a need for more *colonos* and will release more land to be allotted to their individual use in return for their services on the owners' land. With the independent owners of small farms there is the problem of substituting some form of coöperation and supervision to replace the *mayordomo* and the communal form of government (which includes many features of actual community systems) to which they have been accustomed on the *hacienda*. To manage farms of their own efficiently they must have considerable instruction and advice until they have adjusted themselves. What the government hopes to work out among these independent farmers is some form of the communal system applied to the operation of the farms but not affecting their individual ownership.

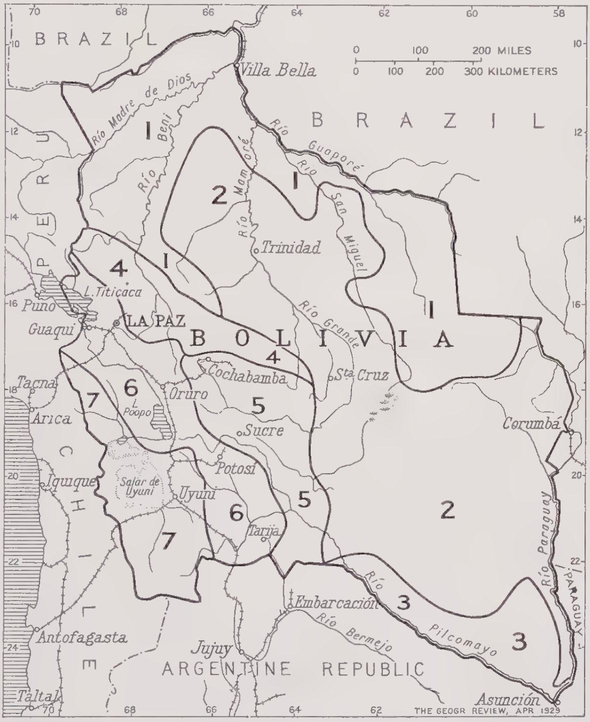

FIG. 1—Agricultural regions of Bolivia. 1, rubber forest region; 2, eastern potential grazing region; 3, Chaco quebracho-grazing region; 4, Yungas; 5, corn and general farming region; 6, Central Andean crops and grazing region; 7, arid Andean grazing region. Scale 1:19,500,000. (The boundary between Bolivia and Paraguay is according to the author. Compare the note "The Bolivia-Paraguay Boundary Dispute," *Geogr. Rev.*, Vol. 19, 1929, pp. 151–153.—EDIT. NOTE.)

AN AGRARIAN POLICY

The government hopes also to arrive at some plan for releasing more land for individual ownership. Limiting the size of the large estates has been suggested. It is recognized, however, that such a method would be revolutionary: it has never worked elsewhere in South America. The government desires that its agrarian policy shall be in all respects evolutionary rather than revolutionary. Much thought is, therefore, being given to developing a plan for the purchase of land by the government for redistribution in small plots at a reasonable price and on easy terms. It is to be understood that these plans for readjustment apply not to the Cochabamba Valley alone but to all of the farming areas outside the community holdings.

In fact the working-out of a national land tenure system for the Indians would seem to be one of the most necessary items in the solution of the whole agrarian problem. Theoretically the Indians can purchase and hold land in any part of the country; but, in practice, the owners of the large estates object to selling land to them. This attitude is the natural attitude of people who have been landowners for generations toward relinquishing any part of their holdings. They are influenced also to some extent by the fear that the increase in individual ownership will bring about a decrease in their own available labor supply. It is certain, however, that the Indian *colonos* on the *haciendas* work more efficiently on the plots of land allotted to them for their individual use than on the *haciendas*. It is believed, therefore, that, with a scientific distribution of larger acreage, the introduction of modern farm tools, improved methods of cultivation, better marketing agencies, and well considered laws for the protection of the Indian farmer, his standard of living could be greatly elevated and his usefulness as a citizen correspondingly increased. Gradual progress toward individual ownership of the land for the most capable Indians is the problem which the government is trying to solve.

The community Indians are bound to their system by strong traditions and practices that reach far back of the Spanish Conquest and even of the Inca Conquest. In spite of the fact that their holdings are now, in general, confined to the less desirable areas—districts off the main routes—they seem contented with the communal system. There is much, however, that can be done to improve farming methods on these communal holdings as well as on the Altiplano as a whole. Better methods of fertilization, of crop rotation, of cultivation, and of marketing would greatly increase the aggregate production of the Altiplano. Dairy breeds of the more hardy species have been successfully tried out, and their distribution should be extended. This will involve a thorough study of problems of stock feeding and the introduction of forage and grain crops to supplant or supplement the present system of natural grazing. The chief difficulty in introducing modern methods will be encountered in dealing with the community Indians, whose present methods are deeply rooted in century-old traditions.

THE PROBLEM IN THE YUNGAS

In the Yungas region the chief problem is scarcity of labor. There are no such large numbers of *colonos* on the Yungas estates as on those of the highlands: 12 to 20 families to an estate is the rule in the former, while in the latter it may be from 60 to 150 families or more, according to the location. Estates, also, are in general much larger than in the highlands, and allotments of land to the *colonos* are correspondingly larger. Harvesting of the coca crops, as well as the coffee and cacao crops, requires skilled labor; and the owners must therefore depend upon their own *colonos* for this work. Fortunately there is little or no overlapping of the harvest seasons of these crops. At certain times of the year, however, outside labor must be sought for the cultivation of the crops, particularly for weeding the coca plants. The Highland Indians are the source of this labor, but they are not adapted to the semitropical environment of the Yungas. Change of climate and tropical diseases, particularly malaria, make the Highland Indian fearful of the Yungas and seriously limit the capacity for work of those who brave the dangers. Concerted efforts are being made by the Society of Proprietors of the Yungas to combat malaria, and it is hoped that the Rockefeller Foundation may eventually be able to assist in the work.

The Society of Proprietors of the Yungas is an association of the owners of the Yungas estates organized for the control of the coca trade, the development of roads, and the collection of local taxes. These taxes are of two sorts: a toll tax imposed upon the Indian packer for use of the roads and an export tax on the coca which is paid by the producer. Both taxes are applied to the maintenance of roads. The Society has now definitely undertaken to solve the labor problem. One method proposed is to import Highland Indians in relays for short periods only. Another is to construct motor roads to carry the heavy traffic—coca, coffee, sugar, and rice—to the Altiplano and thus release for farm work a considerable body of laborers who are more or less acclimated to the Yungas but who find an occupation more to their liking in the transportation of goods over the trails between the Yungas and the Altiplano. Introduction of modern machinery adapted to use in the region will do much to reduce the number of laborers needed for tilling the soil and cultivating the crops.

Work on the motor roads is well under way. Construction on the extension of the railroad to the Yungas has now been abandoned, and a motor road paralleling the railroad has been completed to the present end of the railroad, while construction is now under way on two branch roads from this point which will be extended to Ubana and Coroico respectively. The country is confronted with many other transportation problems, all of which are under study in the Ministry of Public Affairs.

AGRICULTURAL SCHOOLS

One of the greatest needs of the country is agricultural schools. Bolivia has now two such institutions. The recently established school at Tarija has 36 students, the much older school at Cochabamba about 80. The average age of the students is between 18 and 21 years. Complaint is made that these schools are technical rather than practical. Their students, with the exception of a few who go back to their own farms, are in training for laboratory and office positions in the Ministry of Agriculture. The real need of the country is for schools to train young men in modern methods who will go out to positions as *mayordomos* on the *haciendas* or to farms of their own. Intermediate schools of agriculture located in the various farming districts are needed, where instruction can be given in the peculiar problems of the district and in the methods and machinery best suited to their solution. These schools should be located on experimental farms or operated in collaboration with near-by *haciendas* and small farms, so that instruction may be given practical application on the land. There are no experimental farms in Bolivia. They are particularly needed for the demonstration of modern farm machinery. The farming districts are so widely separated, however, that it is doubtful if any centrally located experimental farm would solve the problem. A traveling exhibit of farm machinery would perhaps be more practical. To send practical farmers to study conditions in other countries, and students to specialize intensively in the various phases of the farming industry, would be more beneficial than to graduate large numbers of men trained only in laboratory and office technique. In addition to agricultural training, education of a practical sort adapted to the needs and abilities of the people is the great need of all the farming districts for whites as well as for Indians. Only by better education can a desire for higher standards of living be aroused and developed that will lead to the demand for greater acreage returns.

PROPOSED STUDIES

Unfortunate circumstances have in the past prevented Bolivia from recognizing her more vital problems; but we are now awakening to our needs and our potentialities. We have begun first with the reform of our finances. The Kemmerer Mission has studied our financial status and has made recommendations that we are now attempting to put into practice. Once the finances of the country are on a firm basis, the study of our natural resources will follow. Mining has been our basic source of income; but, great as is our mineral wealth, the expansion of our population forces us to look to the development of our agricultural resources.

There should be, first of all, statistical knowledge of our needs and resources—general at first, more intensive as the work proceeds. No agricultural statistics have been gathered in the past, and we are at present organizing machinery for the collection of the simple but complete information that is our first need. Later more intensive studies will have to be made. Our areas of present cultivation are concentrated around the centers of population, at the mining centers, and along the main transportation routes; but our tillable lands extend to the edge of the tropics. A precise knowledge of the area and production of our cultivated lands is essential as well as a knowledge of the character of the lands most easily available for future colonization, of the crops best suited to them, and of the capacity of the market for those crops. Areas in the northern rubber forest are still a mystery as to extent and productivity, as are also the eastern grazing *llanos* and the Chaco quebracho-grazing region.

THE STAGNATION AND DISSIPATION OF THE LAST ICE SHEET

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THE aim of the argument that follows is to show that the last ice sheet that covered New England and neighboring regions did not retreat as has been believed hitherto, but that it stagnated and disintegrated *in situ*. To make the case clear, it is presented in this way: An initial situation is assumed analogous to that which obtained in New England for some time prior to the dissipation of the last Pleistocene ice. With this situation as a starting point, two different methods of ice dissipation are successively considered. These are (1) retreat of the ice due to excess of melting over alimentation, with the preservation of a well defined glacier front; and (2) dissipation of the ice as a "dead" or stagnant mass resulting from total loss of forward motion while at its maximum southward extent. The expectable consequences of each method of disappearance are deduced. The deduced consequences are then compared with the field facts, and the conclusion is reached that the ice sheet in this region lost its motion and melted away in place. The detailed criteria of stagnation have been worked out during two years' continuous study of Connecticut, but they apply equally well to other areas.

The "Normal Retreat" Explanation

We have as an initial situation a thick ice sheet covering a dissected upland whose summit levels and chief drainage lines incline gently southward. Movement in the mass is maintained; consequently a marginal morainic ridge is built up at the southern edge of the ice, beyond which an outwash apron develops. As melting came to exceed forward motion, the ice front would recede northward into an area of gradually increasing relief. The effect of the relief, coupled with melting, would impose an increasing lobation upon the ice front. Local halts and readvances of the ice would result in the building up of crescentic recessional moraines in parallel series across adjacent valleys. Steep slopes and lack of débris would probably prevent or minimize moraine deposition across the intervening ridges. South of each moraine, stratified outwash deposits would be laid down. In valleys directed northward, outflowing water would be impounded between ice lobes and valley heads, in some cases spilling over divides. Deltas would be built up in the temporary lakes so formed.

The building of each new recessional moraine would be attended by channeling by proglacial streams of the moraines already formed, and by dissection into terraces of the earlier outwash. Marginal streams escaping along the edges of valley lobes would lay down débris partly on and partly against the ice. With retreat of the lobe front these deposits would become kame terraces.[1] The infacing slopes of these terraces should exhibit evidences of planation, and the bedding should be correspondingly contorted as a result of the streaming of live ice past them during their deposition.

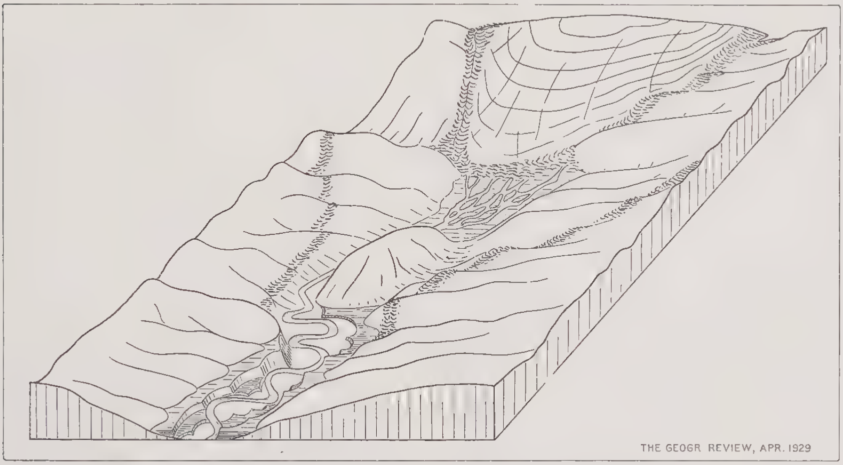

FIG. 1—The results of normal glacier retreat. The front of a valley ice lobe is shown in a position of temporary halt, concurrently building a looped recessional moraine Proglacial streams are building an outwash apron. Down the valley, the position of a former halt is indicated by an older recessional moraine and outwash apron, now extensively trenched by the stream and cut with concave meander scars and local terraces. Contrast with Figures 2 and 3. Length of section, say four miles.

With the final retreat of ice from the region the forms left in the valleys should then be (1) festoon-like recessional moraines channeled by proglacial streams and (2) outwash terraces of sand and gravel exhibiting fluviatile bedding, erosional faces, and occasional concave meander scars. The longitudinal profile of each terrace should be a curve (a) concave upward and (b) traceable northward into a specific recessional moraine, where it should end abruptly. The terraces near the lower ends of the principal valleys should yield evidence of prolonged erosion, since throughout the entire period of retreat most of the meltwater must have passed through them (Fig. 1). Each constructional form, whether moraine or glaciofluvial deposit, should bear evidence of having been in contact with ice at its upper or north end and, in the case of kame terraces, at the sides also. No forms except eskers should show that they were banked against ice on the south.

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[1] R. D. Salisbury: The Glacial Geology of New Jersey, *Geol. Survey of New Jersey*, Vol. 5, 1902, pp. 121–124.

W. C. Alden: The Physical Features of Central Massachusetts, *U. S. Geol. Survey Bull. 760B*, 1924, pp. 47–50.

OBJECTIONS TO THE "NORMAL RETREAT" EXPLANATION

When the explanation outlined above and its logical consequences are checked against the field evidence, difficulties, inconsistencies, and contradictions appear. These will be considered categorically.

Lack of recessional moraines. Although well developed marginal moraines are present on Long Island, along the Rhode Island shore line, and in the Cape Cod region, recessional moraines do not exist in Connecticut or in Massachusetts west of the Boston Basin.[2] Further, none has been reported from Vermont, New Hampshire, or the Hudson-Champlain depression in New York.[3] In view of the great development of such features in the western part of the Great Lakes territory their absence throughout the region to the east is striking.

Lack of outwash plains heading in fosses. Granted for the sake of argument that the ice could have retreated without leaving recessional moraines, at every halt outwash plains would have been banked up against the valley ice fronts, sloping southward with profiles concave upward. With retreat of the ice from such positions of halt, the heads of these outwash plains should have been left as embankments facing north across depressions of the fosse type. Neither extensive outwash plains, embankments, nor fosse depressions exist.

Lack of disturbance. Kame terraces are notably rare, there being no more than a dozen pairs of them within the entire area of Connecticut. Those present show (1) continuous ice-contact slopes with marked salients and reëntrants and (2) stratification unaffected by crumpling or contortion. If live ice had been streaming between the terraces during their construction, the abrupt terrace salients would have been planed away and the adjacent bedding notably disturbed.

Presence of undisturbed ice-contact slopes flanking the valleys. The lower ends of the valleys, especially of the major valleys, after being cleared by ice retreat must have carried off the bulk of the proglacial water derived from farther north. Yet the actual facts are these: the few large valleys have suffered negligible proglacial and postglacial stream erosion; the many smaller ones, comprising all the rest, have suffered absolutely none. In the overwhelming majority of cases, the valleys could not show signs of less erosion if the ice had melted only yesterday. These valleys are without exception flanked by extensive terraces of sand and gravel, in many cases far wider than the channel depressions occupied by the modern streams. With the exception of a single reach of the Connecticut River, the streams do not meander; they impinge but rarely against the terrace faces, which are almost all deeply indented, pitted ice-contact slopes, as fresh as when the retaining glacier masses disappeared.

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[2] Both F. B. Taylor and W. C. Alden have described "terminal moraine" deposits in Massachusetts. Their interpretations are discussed by the writer later in the present argument.

A possible exception to the statement in the text is the Newington Moraine in southeastern Maine. It consists of stratified materials and has been described as having been built up beneath the sea.

[3] Certain isolated patches of stratified "kames" have been described from near Bethlehem, N. H., but were referred to deposits in marginal static waters.

Explanation by Stagnation

The initial situation again involves a thick ice sheet covering an inclined dissected upland, all parts of which are above the level of the sea.[4] But in this case it is assumed that throughout the period of greatest advance the ice has gradually lost the capacity to move until it has become universally stagnant.

Differential melting. The disappearance of the ice, unchecked by further forward motion, is forced to depend exclusively on the rate of melting, which in turn depends on the degree of exposure to the sun's rays. This degree of exposure is roughly uniform for the whole surface as long as no rock material projects above the ice. But as soon as surface ablation causes the appearance of a single nunatak, melting of the surrounding ice becomes a variable factor. The ice in immediate contact with the rock "island" melts faster than the rest of the ice because the strong radiation from the rock slopes is added to the direct effect of the sun's rays. The ice south of the rock melts more rapidly than the ice on the north because it is not protected by the rock from the sun. The ice on the west of the rock is melted more quickly than the ice on the east, because it is exposed to the direct rays of the sun during the afternoon, when the sun and radiation combined beat upon it with greater heat than during the morning. Thus the rate of melting is differential; it is differential because it is controlled largely by topography; and it is not affected by ice motion, the ice being stagnant. Once this principle is set up, it needs only the gradual appearance of additional nunataks for its extension and their gradual increase in size for its intensification. It follows that in time the ice must vanish over the highlands and must linger in the protected lowlands.

The difference in rate of disappearance between highland ice and lowland ice is increasingly accentuated by the fact that the meltwater that escapes from the vanishing highland ice necessarily washes the entire débris content of the ice, plus much of the surface débris of the newly exposed highlands, down on to the surface of the lowland ice, where much of it remains as an insulating blanket, sheeting over the glacier remains and materially retarding their rate of melting.

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[4] This element of the problem is considered in more detail later in the argument.

Vegetation may gain an extensive foothold on this coating of glaciofluvial waste, still further checking the melting of the buried ice below.

Escape of meltwater. Since the melting rate around the base of the original nunatak is greater than the melting rate farther from the nunatak, the ice surface must slope inward from all sides toward the rock mass. The result is a marginal lake of meltwater that fringes the periphery of the rock "island" and that drains off englacially or superglacially. As other nunataks appear, additional lakes develop. The lakes increase somewhat in width and at the same time attain greater and greater linear extent by coalescence as the ice is lowered by surface ablation and the total area of exposed rock surface equals and then exceeds the total area of ice remaining in the valleys. The lakes now exist in pairs that are marginal to the ice mass in each valley. If the valleys were straight smooth-sided unbroken troughs, the lakes would not exist; instead each valley would contain a pair of marginal streams flowing uninterruptedly to the sea. But the valleys, being preglacial stream valleys, are crooked. Moreover, they have lateral spurs with profiles showing rock knobs and sags; and the divides between them are studded with preglacial gaps. Hence the marginal waters are impounded back of individual bends and spurs, and, being sealed off laterally by the residual valley ice, they overflow through the sags and gaps in the rock spurs and divides into lower basins also partly walled by ice. Hence from the time of the first few nunataks the proglacial drainage takes the form of long irregular chains of narrow paired lakes, with levels descending southward,

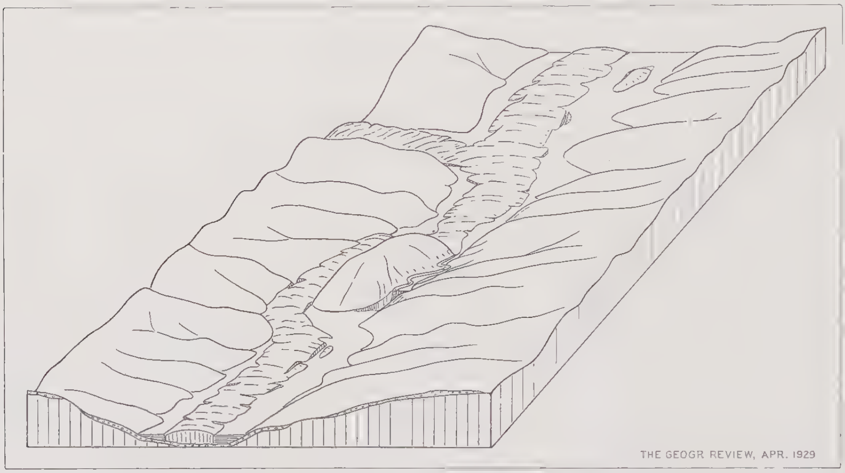
THE GEOGR. REVIEW, APR. 1929

FIG. 2—The process of dissipation *in situ.* A residual mass of stagnant, deeply crevassed ice occupies a valley. It is flanked by two marginal lakes, of which the higher is dammed by the ice where the valley is constricted, and spills over a marginal bedrock channel into the lower. The spillway that controls the lower lake is down the valley beyond the near end of the diagram. Marginal ice-contact terraces are shown in section. See Figure 3.

separated by rock channels and spillways, constantly shifting to lower and lower levels as shrinkage of the valley ice remnants successively uncovers lower and lower spillways in the preglacial rock surface. In spite of the thick débris with which the valley ice is blanketed, melting along the ice margins is continuous and relatively rapid because of the marginal concentration of drainage. Concentration results in (1) the exposure of bare ice by the washing away of the protective débris and (2) increased melting effected by the water itself.[5] The general result is *shrinkage* of each mass of valley ice, not in any fixed direction but radially inward from the valley sides.

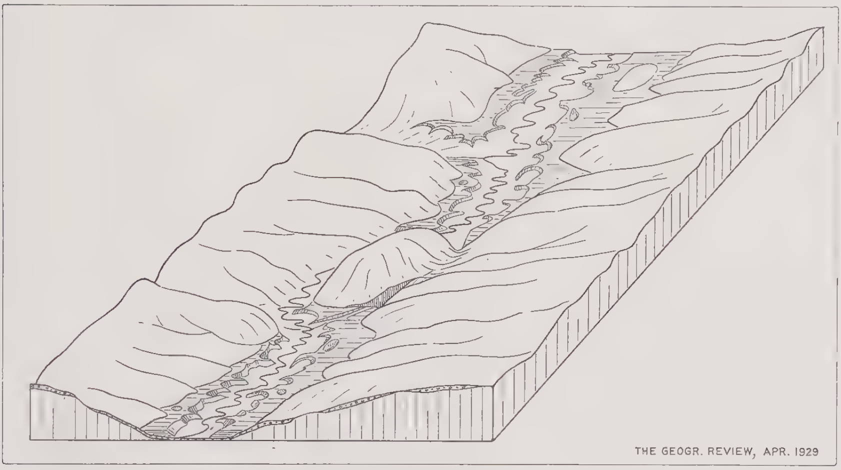

FIG. 3—The results of dissipation *in situ*. The ice has melted out of the valley shown in Figure 2. The lake terraces are drained, and their faces appear as exact counterparts of the margins of the former ice mass. Kettles appear here and there on their surfaces. The spillway channel is abandoned, and the postglacial run-off follows its preglacial course through what is essentially a single elongate kettle.

Deposits in the glacial waters; glacioaqueous sedimentation. The débris from the newly exposed hill slopes and from the melting ice is washed into the marginal lakes, where it is partially sorted and deposited in delta form. The foreset beds in any delta dip toward the spillway that drains the lake. If the spillway continues to function, the lake gradually fills up with a compound delta deposit, one side of which is banked against a wall of valley ice, and the topset beds merge upward into cross-bedded glaciofluvial deposits. Until the lake fills up in this manner, all of the detritus is dropped to the bottom of the ponded water, and little or none escapes over the spillway. With the filling-up of the lake, however, débris is carried over the spillway and finds its way into the next lake down the valley (Fig. 2) or even over a divide into an adjacent valley.

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[5] I am indebted to Mr. Aaron Waters for the clarification of this point: As the ice margins shrink away from the nunataks, the effects of radiation decrease to a negligible quantity at some undetermined distance from the nunatak. The continuation of marginal melting must be due to convection currents in the marginal lakes. The solar heat applied to lake surfaces and the chilling of the water columns in direct contact with the ice together set up convection currents. The effect of these currents is the application to ice melting of all the heat received by the water. The ice margins therefore melt faster below the lake surfaces than above them, causing overhanging ice cliffs capped with débris.

Upon the disappearance of the ice the forms left should then be terraces banked along the valley sides (Fig. 3). The terrace faces should be ice-contact slopes whose irregularities are a faithful cast of the irregularities in the margin of the former retaining ice. Some of the terraces should be horizontal and should show simple delta structure. Others should have the longitudinal profiles characteristic of streams and should show fluvial cross-bedding superimposed on delta stratification.

If, however, during the shrinkage of the ice a new and lower notch in the bedrock should be uncovered, the existing lake water would be suddenly drained off to the level of the new spillway. The former spillway and the débris deposited in the lake at the higher level would be left high and dry. The forms left by final melting would then include two terraces instead of one. The uncovering of new and lower spillways might occur repeatedly, depending entirely upon the number of sags and notches present in the bedrock profiles. In this way whole flights of terraces, each controlled as to altitude by a rock spillway, might be left.

Crevasses once developed in a stagnant ice mass could not close; through these, hydrostatic connection between the two troughs marginal to a given ice mass might be maintained. In this way the lakes on both sides of the ice could be controlled by a spillway on only one side; after draining, their deposits would appear as paired terraces at accordant levels.

If the lower slopes of the preglacial valley side have a gentler inclination than the higher slopes, then each lake must be broader than its predecessor, and opportunity for the deposition of fine sediment must steadily increase. Therefore in any one flight of terraces the proportion of fine component material should steadily increase downward.

Streams trenching a broad terrace recently drained, during the existence of a lower lake, would cut valleys graded with respect to the lower lake. These high-level graded valley bottoms should be preserved in the valley sides of the modern streams.

With the final melting out of the ice from any stretch of valley, the resulting trench between the lowest marginal terraces would be essentially a linear kettle—bounded laterally, and in some cases longitudinally also, by ice-contact slopes (Fig. 3). Some linear kettles so formed would carry drainage, others would not. The presence of drainage would depend on whether or not proglacial run-off entered the valley in question.

In the case of those depressions that carried run-off the water would have little opportunity to erode the low-gradient bottom. If the final melting out took place after proglacial drainage had ceased to enter the head of the valley, the diminished postglacial run-off from local precipitation would provide only an underfit stream wandering through a meadow-like bottom with little or no power to undercut the bordering ice-contact terrace faces of sand and gravel.

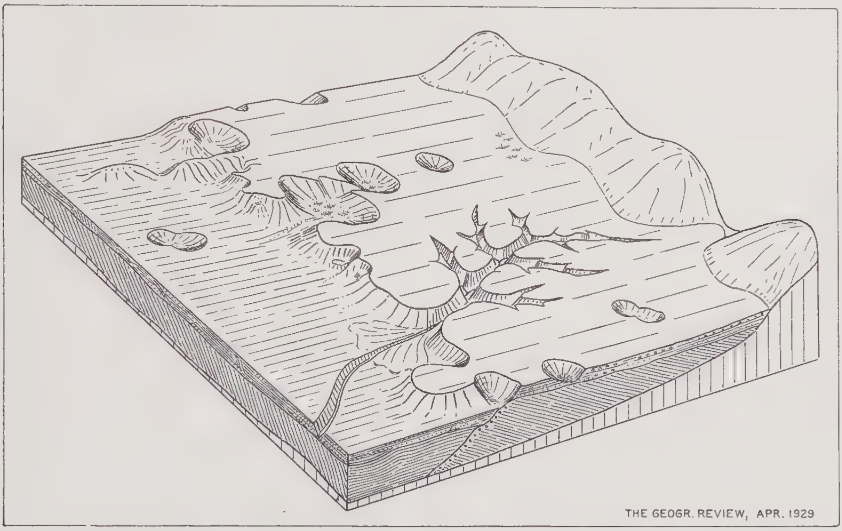

FIG. 4—Ideal lake terrace with ice-contact slope. Characteristic mammillary faces are shown in contrast with the sharp walls of a postglacial gully. Kettles and crevasse fillings appear in their proper relations. Near the head of the gully appears the abandoned rock spillway that controlled the terrace-forming lake level. Note the bedding foreset toward the spillway. The lower terrace rests *against* the higher one, and its bedding indicates a spillway situated somewhere in the direction of the observer. Length of block, say one-half mile.

Only in major valleys occupied by large streams could local undercutting occur.

FIELD FACTS SUPPORT THE EXPLANATION BY STAGNATION

The field facts exhibited in Connecticut and adjacent regions are universally in accord with the view that the ice disintegrated *in situ* as a stagnant mass. They coincide point by point with the expectable results of stagnation.

All the facts cited in objection to the "normal retreat" theory are explicable only on the basis of stagnation. These are (1) the absence of recessional moraines and outwash plains with fosse relationships at their heads, and (2) the lack of proglacial or postglacial erosion of the glacial deposits in the lower as well as the upper reaches of the valleys. Absence of recessional deposits is a fundamental necessity for an explanation based on stagnation; furthermore, it is impossible that the lower ends of the valleys should have escaped erosion unless they were occupied by stagnant ice throughout the entire epoch of deglaciation.

Every additional fact supports the same conception. The chief evidences are as follows: The valleys are flanked at various levels by lacustrine terraces of sand and gravel. Each terrace is essentially horizontal, and each is traceable into a spillway or notch in the bedrock at an approximately accordant level. The faces or fronts of the terraces are with few exceptions ice-contact slopes. Some are slightly modified; most are not modified at all. Their characteristic salients and indentations are exact counterparts of the indentations and salients in the edges of the former adjacent ice masses against which they were banked (Fig. 4). These irregularities could have been thus universally preserved only by the retaining ice having lain stagnant throughout the building of the terraces. Furthermore, the ice-contact slopes face south as well as north, east, and west, indicating that the ice did not melt backward in any specific direction but that it shrank radially away from the valley walls. The postglacial stream channels are merely drained elongate kettles.

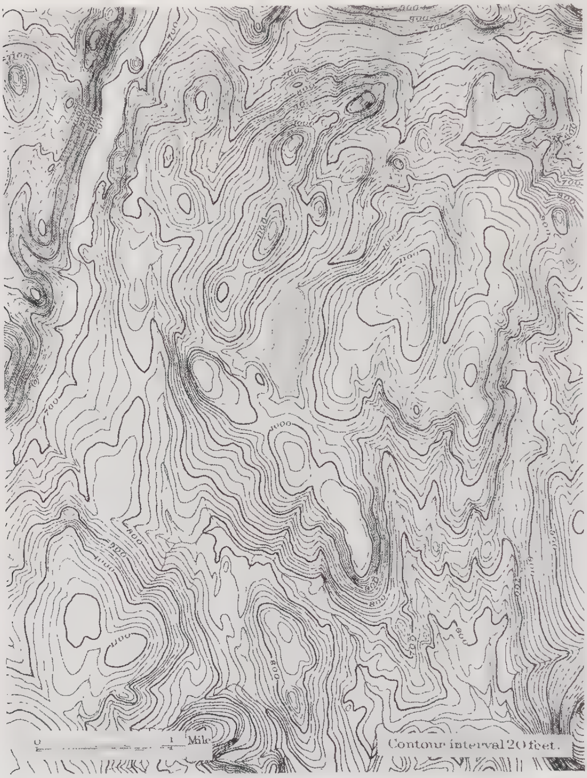

Fig. 5—Part of the Winsted, Connecticut, quadrangle (U.S. Geological Survey) showing "beaded" interfluves characteristic of New England topography. The underlying rock is chiefly gneiss.

Significance of the Spillways

Under conditions of normal stream erosion the small opposing tributaries to larger parallel valleys head alternately into the intervening interfluves and thus form zigzag divides. Throughout southern New England the opposing tributary creases more commonly head opposite one another, giving the interfluves a gently notched effect in longitudinal profile and a pronounced beaded appearance in plan.

Throughout the same region channels occur marginal to and paralleling the valleys. The channels are excavated in bedrock. Some are notches in spurs; others are long creases high up on smooth spurless valley sides. The number of channels in Connecticut alone reaches many hundreds. It is obvious that some are structurally controlled by faults and stratigraphic contacts. It is equally obvious upon close examination that the majority are independent of structure. The beading of the interfluves and the common presence of channels marginal to the valleys together give a texture to the regional topography that is characteristic and unique (Figs. 5 and 6).

The sags in the divides and the marginal channels were cut in part at least by glacial waters. This is proved by the fact that most of them are closely associated with the deposits of marginal glacial lakes, now left as ice-contact terraces of sand and gravel. The terraces lead into the channels at accordant elevations, showing that the channels acted as spillways for the lakes and were themselves trenched by the water that flowed through them. Streams flowing along the edges of ice masses whose margins rested firmly against the gentle side slopes of valleys might in time entrench themselves in the rock and so remain, independent of the shrinking ice. Such marginal slots have been observed in the Alps by the writer and have been described from New York by Rich.[6] Slots so formed might become the

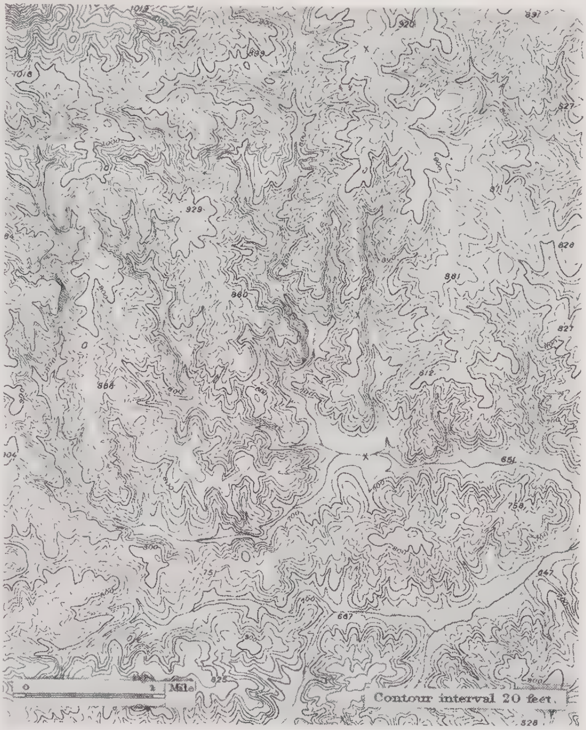

FIG. 6—Part of the Callands, Virginia, quadrangle (U. S. Geological Survey) showing the interfluves characteristic of an unglaciated region. The underlying rocks consist of gneiss and schist. Compare with Figure 5.

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[6] J. L. Rich: Marginal Glacial Drainage Features in the Finger Lake Region, *Journ. of Geol.*, Vol. 16, 1908, pp. 527–548.

Idem: Notes on the Physiography and Glacial Geology of the Northern Catskill Mountains, *Amer. Journ. of Sci.*, Ser. 4, Vol. 39, 1915, pp. 137–166 (especially Figs. 5 and 7 and accompanying text).

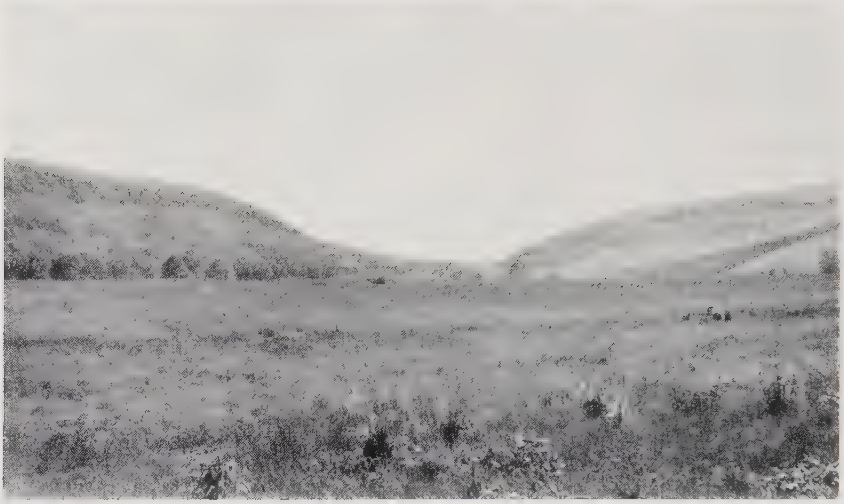

FIG. 7—Spillway of a temporary glacial lake, West Rock Ridge near Mt. Carmel, Conn. Distant view looking south. The notch is cut in trap. The impounded water left the gravel terrace that occupies the foreground. Automobile in middle ground indicates scale.

spillways of marginal lakes and be further channeled by outflow from the lakes. A single epoch of glaciation should provide the requisite conditions for the common development of channels in the region affected. Not all the sags and channels of southern New England, however, were cut during the occupancy of the region by the last ice sheet. Many of them have the broad troughlike cross profile charac-

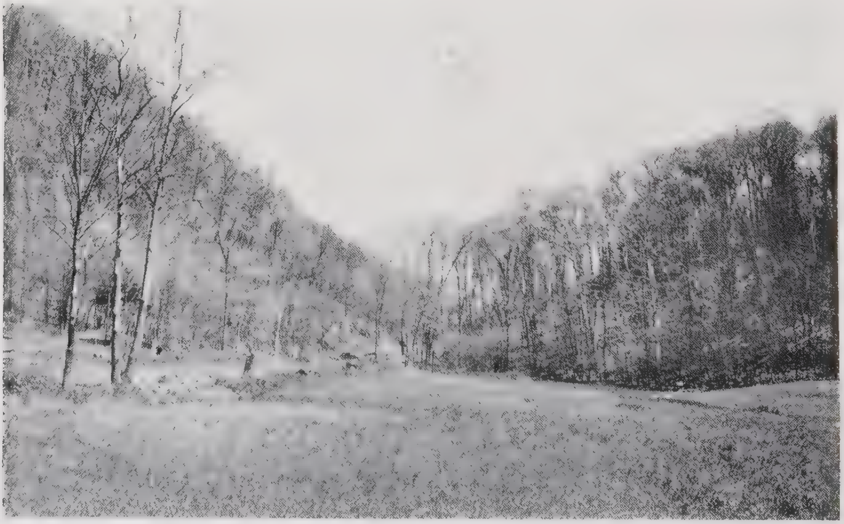

FIG. 8—Spillway of a temporary glacial lake, Guilford, Conn. Detail view looking north up the spillway. The notch is cut in bedrock. The flat in the foreground is underlain by deposits from the waters that issued from the spillway.

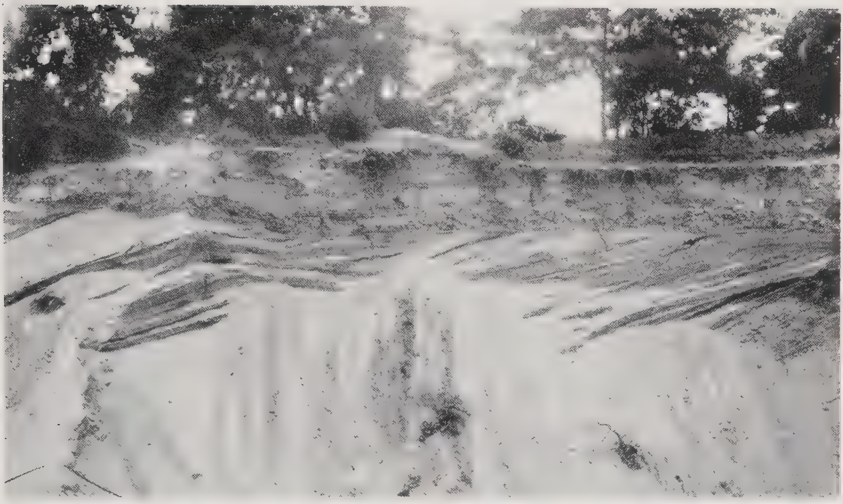

FIG. 9—Delta structure exposed in glacial lake terrace, Waterbury, Conn. This structure is typical of the glaciolacustrine deposits in southern New England.

teristic of glacial scour (Fig. 7). Bedrock exposures in their sides bear marks of glacial abrasion. These must have been present when the last ice sheet advanced over the region. It is probable that they had their origin during an earlier epoch of deglaciation.

COMPOSITION AND STRUCTURE OF THE TERRACE DEPOSITS

Most of the valleys of Connecticut, both large and small, carry pairs and flights of marginal terraces. Reconnaissance observations in adjacent regions show similar relationships. A flight of more than

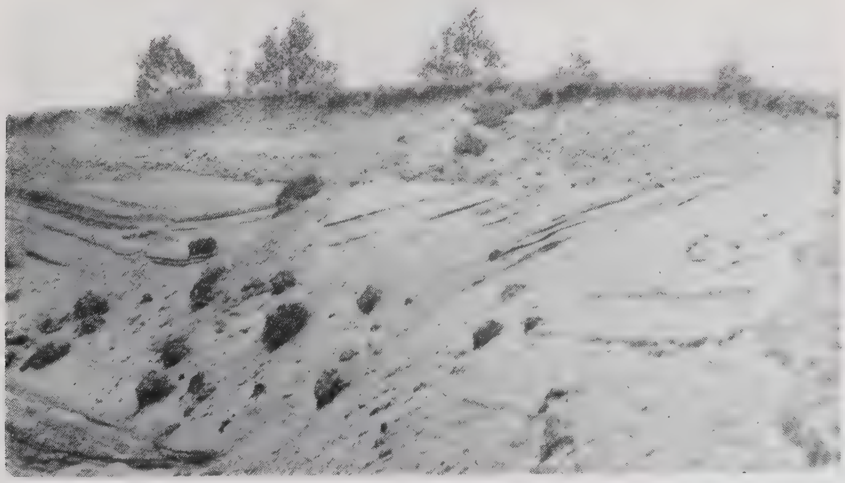

FIG. 10—Topset beds overlying eroded foreset beds in lake terrace, Woodstock, Conn.

fifteen terraces exists in the lower Connecticut Valley. The lower terraces are paired; the higher ones less commonly have counterparts on the opposite side of the valley. The terraces in every valley are composed of stratified sand and gravel, less commonly varved clay. The individual pebbles are partly rounded and reworked, but many show that they were formerly faceted and beveled. Large erratic boulders and local pockets of till are incorporated in the deposits. The material in any one locality is derived chiefly from the local bedrock; but a certain proportion of material from much farther north is present in the major valleys. Delta bedding with steeply dipping foresets is revealed in most of the exposures, proving deposition in ponded bodies of water (Figs. 10 and 11).

Form and Distribution of the Terraces

Two facts concerning the form of the terraces stand out sharply: (1) Nearly all of the terrace surfaces are essentially horizontal from end to end, further indicating ponded water. A few have the longitudinal profile characteristic of streams, but exposures show that this profile is associated with fluviatile stratification superimposed on delta bedding. (2) All but a very few of the terrace faces are nearly continuous ice-contact slopes interrupted only by local slump and, in the case of very large streams, occasional postglacial undercutting. Their outlines are notably and sharply irregular, but the details of the irregularities are commonly cone segments of all sizes, forming amphitheaters and semi-kettles where ice salients existed and mammillary projections where the ice was indented. The terrace surfaces are not rarely pitted with kettles near their ice-contact peripheries, and these same peripheries grade outward through semidetached banks of gravel into wholly detached forms, usually linear, which were obviously the fillings of crevasses in the ice.[7] That these detached and semidetached masses were formed identically and contemporaneously with the continuous terraces is shown by two facts: (1) The tops of the isolated forms are flat and are flush with the adjacent terraces; (2) where pits and road cuts expose both the isolated hummocks and adjacent terrace faces, the same stratification, even to the presence of individual recognizable beds, is common to both. This shows conclusively that all the forms associated at one level were deposited in a single body of water penetrated by ice.[8]

Less obvious but equally important is the fact that the terraces can be traced into rock spillways at accordant levels and that the gravels composing the terraces are foreset toward the spillways. Furthermore, the deposits beyond certain spillways include rock fragments whose places of origin are known and which could have reached their present positions only by coming through the spillways.

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[7] R. F. Flint: Eskers and Crevasse Fillings, *Amer. Journ. of Sci.*, Ser. 5, Vol. 15, 1928, pp. 410–416.

[8] In certain low terraces in the Connecticut Valley, the ice-contact slopes merge locally into less indented faces with gentle slopes, indicating that at times parts of the stagnant ice edge shrank away from the valley wall more rapidly than detritus could be brought in. Instead of being built against the ice margin the terrace fronts in these places assumed a delta-like form.

A peculiarity of many of the north-south streams of Connecticut is that throughout much of their length they hug the western sides of their bedrock valleys. This asymmetry is especially notable whereever the western walls are particularly high and steep (Fig. 17). Since the stream channels are bordered by the glacial terraces described above, with infacing ice-contact slopes, it follows that in each case of asymmetry the terrace on the eastern side of the valley is markedly broader than the corresponding terrace on the western side. The ice-contact slopes indicate that the trough occupied by the modern stream is merely the elongate depression left by the last residual ice when it melted out of the valley. The asymmetry indicates that melting of the eastern margin of the ice due to solar exposure was consistently more rapid than melting of the western margin.

Most of the valleys in Connecticut are of variable width, exhibiting alternate broad reaches and narrows. In many cases the broad reaches are rimmed longitudinally as well as laterally by terraces with infacing ice-contact slopes, breached only by modern through-flowing streams where such are present. In other words, the central portions of these valleys are gigantic kettles. Such a depression, in the Connecticut Valley, extends from the Holyoke Range in Massachusetts sixty miles south to near Middletown, Conn.[9]

The essential universality of terraces with infacing ice-contact slopes is proof that, throughout the entire epoch of deglaciation in southern New England, all of the valleys were occupied from head to mouth by residual masses of ice. On this basis only can the almost total lack of erosion of the terrace faces be explained. If the ice had disappeared from the mouthward portions of the valleys while ice in the headwater areas still discharged proglacial water, erosion in the lower reaches would have been inevitable. The only stream in southern New England which has a broad regional gathering ground is the Connecticut River. Since it drains large areas in New Hampshire, Vermont, and the north, it might be supposed to have discharged meltwater through its mouth long after the ice in its lower reaches had melted out. Although erosion by the river of the marginal terraces in its valley has taken place, the total amount is strikingly slight—slight enough to have been accomplished within a fraction of postglacial time. This being the case, ice must have remained in the lower valley of the Connecticut until after complete dissipation had taken place in northern New Hampshire and Vermont.

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[9] R. F. Flint: Pleistocene Terraces of the Lower Connecticut Valley (abstract), *Bull. Geol. Soc. of America*, Vol. 39, 1928, pp. 216–217.

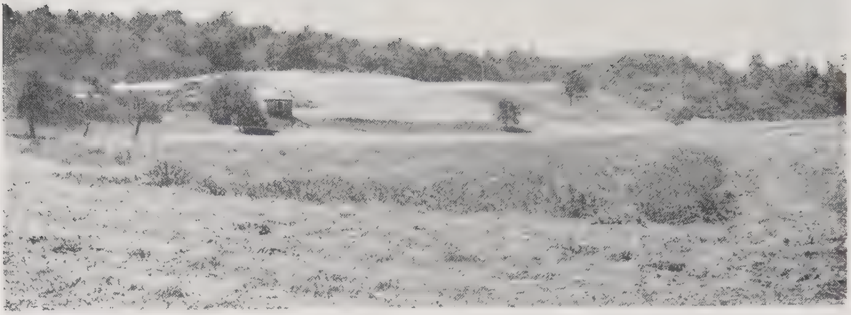

FIG. 11

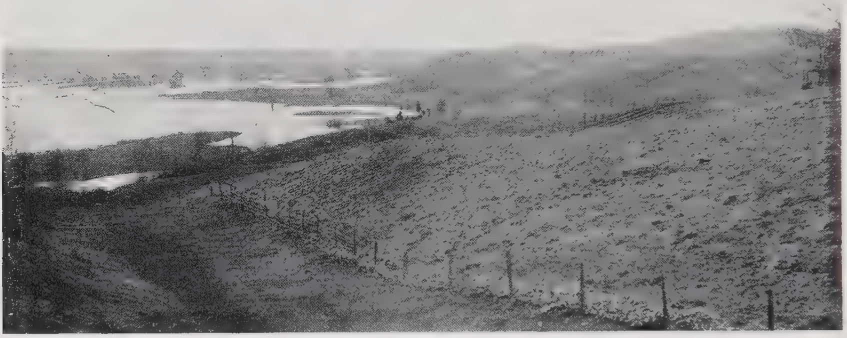

FIG. 12

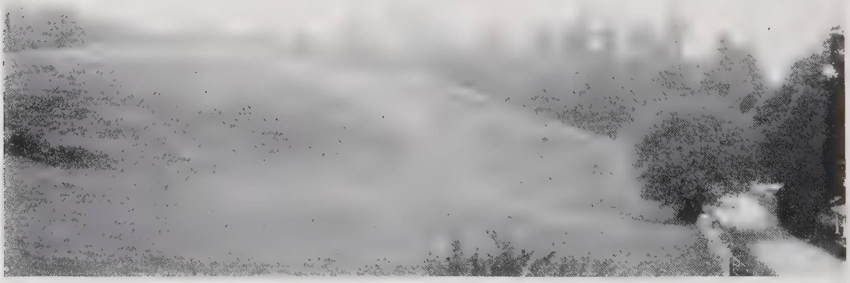

FIG. 13

FIG. 11—Marginal lake terrace with ice-contact slope, Burlington, Conn. The tree on the slope stands in an undrained kettle.

FIG. 12—Lake terrace with ice-contact slope, near South Glastonbury, Conn. The terrace is not undercut by the postglacial Connecticut River, here shown in flood.

FIG. 13—Mammillary ice-contact slope, Botsford, Conn. The top of the associated terrace appears at the left. The road at the base of the slope follows the top of a lower terrace.

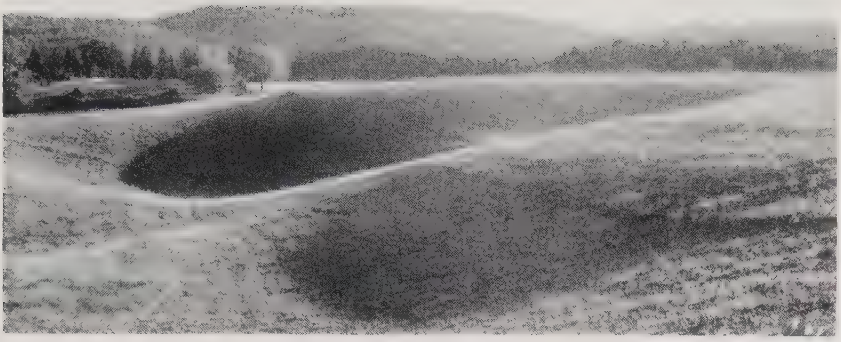

FIG. 14

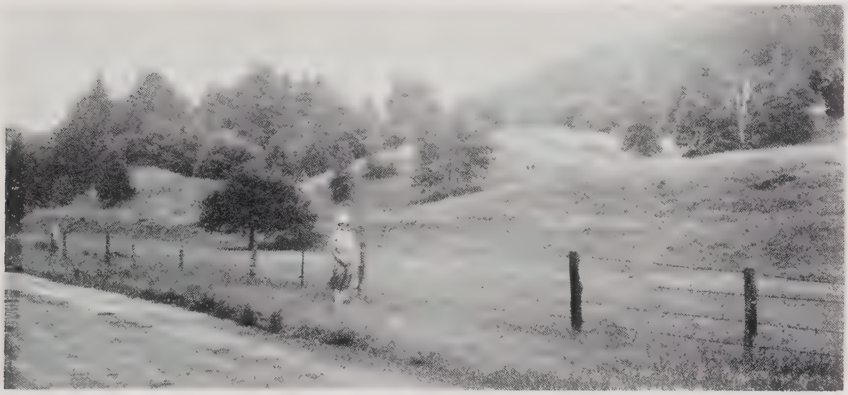

FIG. 15

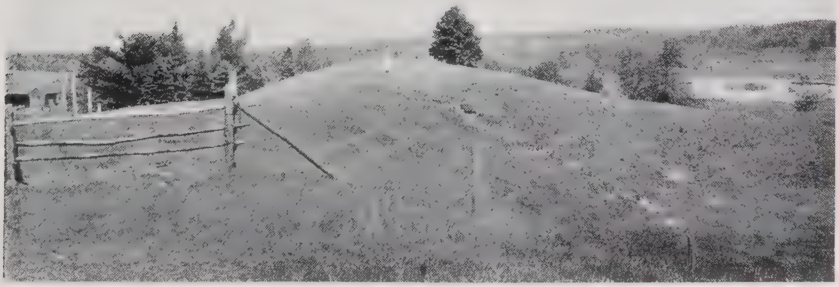

FIG. 16

FIG. 14—Kettles above ice-contact slope, Portland, Conn.

FIG. 15—Hummocky ice-contact slope, Colebrook, Conn. To the right the slope merges into a flat-topped lake terrace.

FIG. 16—A typical salient in a lake terrace, Harrisville, Conn. The salient has the appearance of a short segment of an esker. It is essentially a crevasse filling flanked by semi-kettles.

Evidence of Lingering Ice in the Southern Region

The conclusion reached in the preceding paragraph is sufficiently arresting to require further arguments in its support. The Long Island Sound depression was not submerged in the ocean immediately before or during the occupation of the region by the last ice sheet. This is indicated by four lines of evidence:

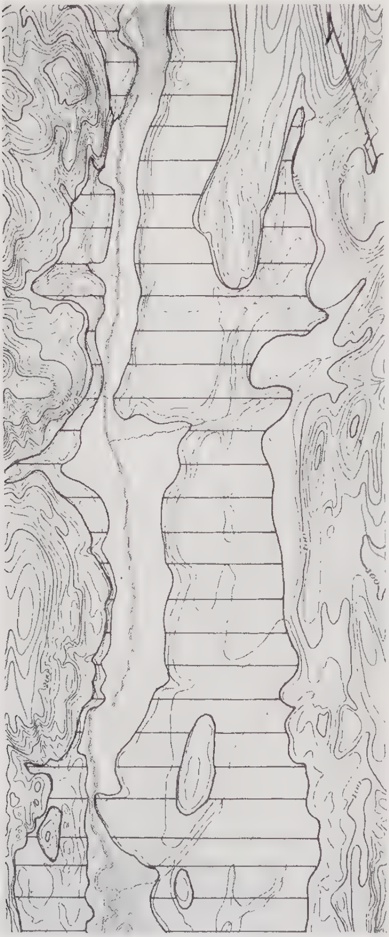

Fig. 17—Asymmetry of the postglacial Quinnipiac Valley between Wallingford and North Haven, Conn. The present channel of Quinnipiac River, flanked by glaciofluvial deposits, lies west of the axis of the bedrock valley. Ruled areas represent glaciofluvial terraces; unruled strip between the ruled areas, the river channel; Unruled strips outside the ruled areas, till-covered bedrock. Length of map, 7 miles. Contour interval, 20 feet.

1. The universal association of terraces with spillways down to elevations as low as 35 feet above present sea level shows that the terrace-building water levels were due to local and not to general marine control.

2. Coarse glaciofluvial deposits indicating high gradients extend marginally down the mouths of the principal valleys. They reach the present shore line on broad fronts and are sharply cliffed by wave action. Since their profiles do not flatten out in accordance with the level of the sea, it follows that this level must have been lower when the deposits were laid down than it is at present.

3. The late-glacial clays at the mouth of the Quinnipiac Valley are varved, indicating deposition in fresh and not in salt water.[10]

4. The presence of extensive ice sheets over large continental areas necessitates a considerable eustatic subsidence of the sea. Antevs has calculated[11] that this subsidence probably amounted to 300 feet during the maximum advance of the last ice sheet. If the total subsidence was only half this amount, the sound depression would still have been above the sea.

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[10] Ernst Antevs: The Recession of the Last Ice Sheet in New England, *Amer. Geogr. Soc. Research Ser. No. 11*, 1922, p. 3.

[11] Ernst Antevs: The Last Glaciation, *Amer. Geogr. Soc. Research Ser. No. 17*, 1928, p. 83.

The direct evidence of lingering ice in the Long Island Sound trough is simple: In several localities terraces with extensive ice-contact fronts face sound-ward close to the present shore line. The parent lakes were controlled by lateral spillways. They could not have been formed in these situations had they not been retained by a mass of ice occupying the present Sound depression.

On the south side of the depression similar relations occur. Woodworth[12] has described a large flat-topped delta on Manhasset Neck, Long Island, with foresets dipping sharply south against the island mass. He states that it was formed in a local glacial lake during the ice retreat. That such deposits are rare on the south side of the Sound depression is probably due to the fact that the residual ice in this trough was oriented transversely to the direction of the Connecticut streams debouching against or upon it, deflecting the water laterally along the present Connecticut shore and preventing the transportation of detritus southward across the trough. This deflection is indicated by the distribution and direction of cross-bedding in certain of the partly submerged proglacial stream deposits that form parts of the present Connecticut shore.

The inner (Harbor Hill) moraine of Long Island continues eastward through Fishers Island and the Rhode Island shore. Back of the moraine in Rhode Island the Manhasset Neck relations are not uncommonly repeated. They are well exposed at Dunn's Corners, near Quonochontaug, where flat-topped stratified gravel benches, evidently lacustrine, rest against the inner (north) slope of the moraine. These facts urge the viewpoint that the ice sheet began to stagnate while the last moraine was building.

The Sound depression is low. It is the lowest depression within the entire region covered by the ice sheet. It is protected on its most vulnerable side, the south, by a steep and continuous rampart consisting of a Cretaceous cuesta surmounted by heavy earlier Pleistocene deposits and a late-glacial marginal moraine.[13] More important still, the ice it held was in an ideal position to become sheeted over with a protective coating of detritus brought down by the Connecticut streams. Evidence has been given of the stagnant ice-block origin of the stream channels even in the mouths of the valleys of Connecticut, and of the lingering of the ice in these positions. It has been shown in an earlier discussion[14] that in the Middletown-Holyoke section of the Connecticut Valley the northern edge of the residual ice mass melted southward at a much faster rate than the southern edge, which melted northward. Since ice remained in these places and behaved in this manner, it is even more certain that it remained in the lower, more protected Sound trough. The ice-contact slopes are present in the valleys and on the higher slopes of the trough. They are nearly submerged and hidden from view on the lower slopes.

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[12] J. B. Woodworth: Pleistocene Geology of Portions of Nassau County and Borough of Queens, *New York State Museum Bull. No. 48*, 1901, pp. 617–670; reference on p. 653.

[13] M. L. Fuller: The Geology of Long Island, New York, *U. S. Geol. Survey Professional Paper 82*, 1914.

[14] Flint, Pleistocene Terraces of the Lower Connecticut Valley.

Woodworth apparently entertained a similar idea. In a paper[15] published in 1903 he made this statement:

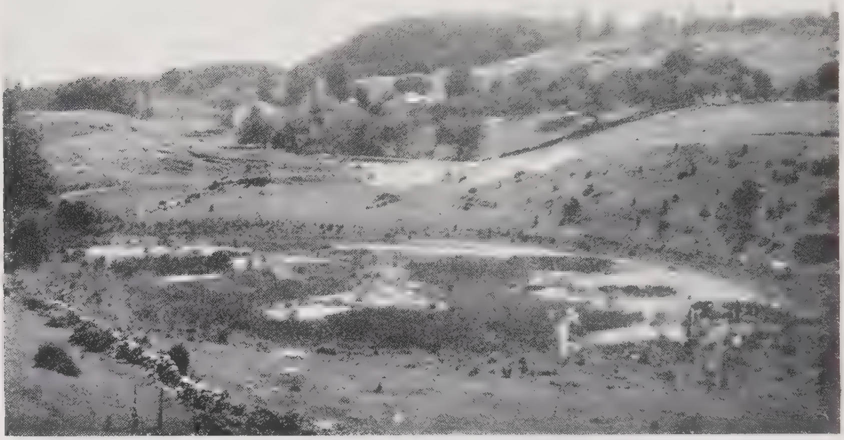

FIG. 18—Typical lake terrace, Franklin, Conn. Detail view of a kettle reëntrant in a continuous ice-contact slope.

"In a paper now in preparation, I purpose to show that in the southern part of Massachusetts the last ice-sheet existed longer, along and off the coast, than it did on the mainland west of Cape Cod bay, thus allowing the formation and temporary existence of what may be termed proglacial lakes . . . held in front of the ice by a glacier-dam crossing the mouths of valleys, already freed from ice."

The subject does not recur in Woodworth's later writings; but the situation hinted at is essentially analogous to that which obtained in the Long Island Sound trough.

The ice may have lasted indefinitely beneath débris that perhaps supported a dense forest growth similar to that on the Malaspina Glacier today. It is not inconceivable that this ice persisted until it was floated and broken up by the postglacial rise of the sea level that converted the great depression into a sound.

In spite of the fact that mean temperature decreases with increasing altitude and latitude and that the ice might therefore be supposed to have melted out of the lower and most southerly depressions first of all, the reverse has been shown to be true. The low southern ice must have been influenced by some protective factor more powerful than the direct effect of temperature. Obviously the opportunity for the sheeting over of the ice with débris would increase with decreasing altitude and latitude. For example, the proglacial water from the entire Connecticut River drainage basin had to pass over and beside the ice in the lower Connecticut Valley and its temporary distributaries, depositing a corresponding volume of débris. The Housatonic, Thames, and other large valleys were affected similarly on a lesser scale.

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[15] R. S. Tarr: Postglacial and Interglacial (?) Changes of Level at Cape Ann, Massachusetts, with a Note on the Elevated Beaches by J. B. Woodworth, *Bull. Museum of Comp. Zoöl. at Harvard College*, Vol. 42 (Geol. Ser., Vol. 6), 1903, pp. 179–196; reference on p. 194.

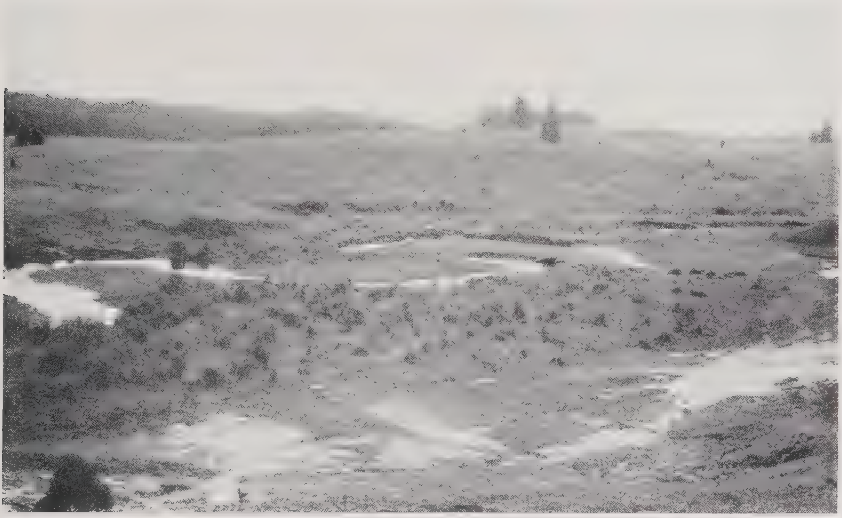

FIG. 19—Typical underfit stream flanked by pitted lake terraces with ice-contact slopes, Suffield, Conn. Postglacial erosion in this valley is negligible.

Sheeting over with débris therefore apparently controlled the roughly reverse order in which the ice disappeared. The deglaciation of any one valley, in which the ice shrank radially from all walls alike and left an ultimate central kettle, was the epitome of the deglaciation of the region as a whole. The first nunataks that appeared above the waning ice sheet may possibly have been furnished by the Presidential Range of New Hampshire. But even if the Connecticut highlands, only one-fifth as high, appeared before the White and Green Mountain masses, the latter would have been deglaciated with comparative rapidity as soon as the melting of the ice over the lower lands was reduced to a negligible rate by the débris coating it must inevitably have acquired. That the rate of melting in the late stages of deglaciation was extremely slow is evidenced by the presence in the Connecticut Valley of ice-contact terraces of varved clay, in which the clays themselves form the projections and reëntrants controlled by the outline of the ice margins.

If the margins of the masses of valley ice had not been continually washed by water, the débris coatings would probably have been eventually let down in confused dumps over the valley floors as the ice melted out from underneath them. Since dumps or "collapsed plains" do not exist in Connecticut, it is probable that the ice was reduced entirely by shrinkage *inward from the sides*, where erosion by marginal streams and melting by lacustrine convection currents were effective. The superglacial débris was undermined little by little by sapping at the ice margins and was incorporated little by little into the stratified marginal terraces.

Errors Involved in Earlier Studies

In discussing the glacial features of the Connecticut Valley in Massachusetts, Emerson[16] repeatedly referred to a uniform ice front that retreated from point to point. His work is based entirely on the assumption of normal retreat; he failed to recognize the ice-contact character of the lacustrine terraces of the region.

At the same time Salisbury[17] discussed in detail the glacial geology of New Jersey. He described ice-contact slopes but explained them on the assumption that in certain places masses of ice remained isolated beyond a receding ice front.

Somewhat later Taylor[18], in discussing the deglaciation of western Massachusetts, proceeded on the assumption, carried over from the relationships in the Middle West, that normal retreat had taken place with interruptions by minor oscillations of the ice. He attempted to correlate the position of the supposed ice front from valley to valley for each stage of halt. The position of the resulting isochronal lines between the valleys was interpolated. Their position within the valleys was determined largely on a basis of the distribution of hummocky topography called "terminal moraines" and "lateral moraines" by Taylor. Recent field investigation by the writer has shown that this topography consists in fact of pitted marginal lake terraces flanked by crevasse fillings. The spillways that controlled the lakes are present as well. The results of Taylor's study represent an attempt to fit the facts into a predetermined theoretical sequence of events.

A similar attempt was made later by Alden[19] in central Massachusetts. Alden's conclusions were predicated on the assumption of a wavering but distinct ice front. Pitted lacustrine terraces were mapped as "terminal moraine," and a provisional isochronal correlation was made which was similar to that of Taylor.

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[16] B. K. Emerson: Geology of Old Hampshire County, Massachusetts, *U. S. Geol. Survey Monograph No. 29*, 1898, pp. 562–654.

[17] *Op. cit.*

[18] F. B. Taylor: The Correlation and Reconstruction of Recessional Ice Borders in Berkshire County, Massachusetts, *Journ. of Geol.*, Vol. 11, 1903, pp. 323–364.

[19] *Op. cit.*

More recently, Antevs made a study of the varved clays in the Connecticut Valley.[20] He prosecuted his study on the assumptions (1) that pronounced postglacial tilting had affected the region and (2) that, because of northward tilting, chains of narrow lakes were ponded off an (assumed) receding ice front, to provide a proper setting for varved clay deposition. The presence of the clays indicated standing water, but the clays were varved; hence the standing water could not be the result of marine submergence. Widespread tilting (unsubstantiated in this region) was invoked to explain the presence of ponded water in the open valleys. If the clays had been studied in conjunction with the ice-contact terraces that flank them, a much simpler explanation of the lakes would have been reached.

Following the methods of Woodworth and of Fairchild, Reeds[21] found evidence of ponded glacial water in the Hackensack Valley and in the lower Manhattan region. He did not trace the shore lines in the field. Instead, he took the figure for postglacial tilt established by Woodworth, and laid off the shore line (assumed to be tilted) on a contour map. He then compared the tilted plane with the actual summit elevations of discontinuous stratified glacial deposits mapped in the Passaic Folio and found that they too rose northward at about the same rate. Of the exceptions—those deposits that rose too high to fit the tilted plane—he says: "The exceptions . . . were in all probability deposited not in Lake Hackensack, but in small lakes which lay at higher elevations hemmed in by early retreat stages of the ice-front and the back slopes of the terminal moraine and of the Watchung Mountains." There is no difference in form and composition between the exceptional deposits and the lower conformist deposits. If the ice be considered to have stagnated instead of retreating normally, all the deposits, regardless of level, are explained in a single simple way—as marginal lacustrine terraces laid down in a succession of lakes, each lower than its predecessor and each controlled by a spillway that could probably be located with ease in the field but with less ease on a map.

Earlier References to the Evidence of Stagnation

References to field relations that could have been brought about only by ice stagnation appeared early in the literature, but the principle involved was either obscure or imperfectly grasped by the various investigators. For example, in 1898 Jefferson[22] reported the discovery near Turners Falls, Massachusetts, of "a curious remnant of sandplain (?) [which] . . . seems to indicate that ice filled this valley all through the building of the plain." The evidence involved was a pair of ice-contact slopes. In 1899 Gulliver[23] recognized that the terraces flanking the Thames River in Connecticut were deltaic in origin and that their faces were ice-contact slopes. He rightly concluded that they were laid down in standing water marginal to an ice tongue but considered the ponding due either to vague "glacial deposits" down the valley or to marine submergence.

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[20] Antevs, The Recession of the Last Ice Sheet in New England (especially Ch. II).

[21] C. A. Reeds: Glacial Lakes and Clays Near New York City, *Natural History*, Vol. 27, 1927, pp. 54–64.

[22] M. S. W. Jefferson: The Postglacial Connecticut at Turners Falls, Mass., *Journ. of Geol.*, Vol. 6, 1898, pp. 463–472; reference on p. 470.

In describing the Wisconsin glacial deposits of New Jersey in 1902, Salisbury[24] repeatedly refers to isolated masses of ice which "when they became small, or when the local topography was unfavorable to motion, [they] became stagnant . . . "

Later, however, stagnation began to be fully realized as a fact in restricted localities. Fuller[25] was apparently the first to marshal the evidence. After studying an area in southeastern Massachusetts he made this definite statement in 1904: "The studies of the present writer in Lake Neponset have led to the conclusion that the ice in that region, instead of retreating with a definite and somewhat regular front, had become absolutely stagnant before the history of the lake began . . . "

After studying another Massachusetts area in 1904 Clapp[26] found that the chief feature in the glacial history of the area was the "decay of the ice *in situ* for many miles back from the ice-front—the decaying glacier consisting of a mass of stagnant ice overlain and buried by sheets of water and by extensive deposits of sand and gravel."

Goldthwait made a study[27] of the Sudbury basin, west of Boston, in 1905. He concluded that a certain delta of the Saxonville sand plain "was built forward from a huge ice-block which occupied part of Lake Cochituate long after the main ice-sheet had left it."

In 1914 Fuller[28] made a second contribution to this evidence after a study of the glacial deposits on Long Island. He spoke of the general absence of retreatal deposits and added, "It is probable that as the climatic conditions ameliorated, the activity of the ice movement gradually lessened and finally ceased, and the margin of the ice sheet became broken up into detached masses as the ice melted. The masses occupying the valleys doubtless persisted longest, especially where covered with retreatal outwash and other débris."

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[23] F. P. Gulliver: Thames River Terraces in Connecticut (abstract), *Bull. Geol. Soc. of America*, Vol. 10, 1899, pp. 492–495.

[24] *Op. cit.*, p. 86 *et al.*

[25] M. L. Fuller: Ice-Retreat in Glacial Lake Neponset and in Southeastern Massachusetts, *Journ. of Geol.*, Vol. 12, 1904, pp. 181–197; reference on p. 181.

[26] F. G. Clapp: Relations of Gravel Deposits in the Northern Part of Glacial Lake Charles, Massachusetts, *ibid.*, pp. 198–214; reference on p. 214.

[27] J. W. Goldthwait: The Sand Plains of Glacial Lake Sudbury, *Bull. Museum of Comp. Zoöl. at Harvard College*, Vol. 42 (Geol. Ser., Vol. 6), 1905, pp. 261–301.

[28] Fuller, The Geology of Long Island, New York, p. 212.

A curious discussion took place regarding the late-glacial history of the White Mountains. In 1904 Upham[29] published the results of a study of a stratified complex in the Bethlehem-Twin Mountain House region, concluding (p. 13) that "a remnant of the general ice-sheet was rapidly and continuously melting back on this tract from northwest to southeast, lingering latest on the [north] flanks of the Mt. Washington and Mt. Willey ranges." He attributed this action to a local glacier that sprang from the high massive to the south.

In 1916 Goldthwait[30] contested this view. He began with a lucid and thorough description of the "Bethlehem moraine" and the "Carroll moraine field" both of which he pointed out are composed almost entirely of stratified drift. He rightly interpreted both as ice-border deposits in static waters and recognized stagnation as a local phenomenon. He spoke (p. 280) of the "kame and kettle topography of the deposits" as "indicating great irregularity in the outline of the ice-border, and requiring the presence of detached masses of stagnant ice in close association with the accumulating gravels and sands. . . . " In the same place he said of a "kame field" near Carroll, N. H., "there is a very noticeable tendency among the hillocks and swells to reach a common level. . . . This accordance of hillocks gives the deposit the appearance of a rude, incomplete delta. The absence . . . of frontal lobes, such as are built by distributary streams on their deltas, may be due to lingering masses of ice at their outer margins." Again he said: "The outwash sands and gravels were discharged southward through the pass into the Ammonoosuc Valley while the ice-masses still lingered there, although the main body of the ice-sheet had retired to the north side of the watershed."

These are all evidences of stagnation. Goldthwait showed that Upham's local glacier did not exist; nevertheless there was a kernel of truth in Upham's contention. The ice did shrink locally southward under the protecting shadow of the big ranges. Goldthwait's excellent description, together with a study of the Whitefield, N. H., quadrangle, indicates that the deposits discussed are marginal lake deposits identical with those in southern New England.

In 1924 Cook[31] perceived the probability of the vast areal extent of stagnation phenomena. After citing the supporting evidence, he formulated this theory: "That part of the [Wisconsin] glacier which had been pushed beyond the mountain barriers south of the

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[29] Warren Upham: Moraines and Eskers of the Last Glaciation in the White Mountains, *Amer. Geologist*, Vol. 33, 1904, pp. 7–14.

[30] J. W. Goldthwait: Glaciation in the White Mountains of New Hampshire, *Bull. Geol. Soc. of America*, Vol. 27, 1916, pp. 263–294.

[31] J. H. Cook: The Disappearance of the Last Glacial Ice Sheet from Eastern New York, *New York State Museum Bull. No. 251*, 1924, pp. 158–176; reference on p. 159.

The present writer came to the same conclusion in 1927 and discovered Cook's paper later during a search for references. The priority of Cook's work is here acknowledged.

St. Lawrence river from the Adirondacks to Maine, became stagnant almost, if not quite, at its maximum extension and never regained its motion."

Effect of Stagnation on Glacial Drainage Changes

Glacial drainage changes were rare in southern New England. Buried channels predating at least the last glaciation exist but are rare. As a rule, the postglacial streams occupy the same positions (in ground plan) as did their respective preglacial predecessors. This unusual case is the result of a combination of two factors: the sharp preglacial relief of the bedrock surface and the stagnation of the ice. It has been shown that the ice that remained longest in a valley did so because it was lower than the adjacent ice and therefore had a better chance to be sheeted over with protective débris. It might be said that the duration of the ice varied inversely with altitude and side-wall protection. It follows that ice remained longest in the deepest parts of the preglacial valleys and that, when at last it did melt out leaving kettle trenches flanked by lacustrine terraces, the postglacial drainage followed the trenches. These trenches were precisely in the positions of the preglacial streams except in those valley reaches where the ice lay longest under the protection of steep western walls and where the modern streams are not therefore flowing vertically over the deepest parts of the bedrock valleys. Thus glacial drainage changes in this region were only temporary. Abnormal drainage functioned only while ice lay in the valleys; afterward the drainage lines automatically resumed their former position.

Stagnation and the Succession of Varved Clays

The varved clays of the Connecticut Valley have received such wide attention during recent years that a special discussion is necessary to show their relation to the history of the stagnant ice. The assumptions made by Antevs regarding their origin have already been outlined (p. 277). The present argument has shown that these assumptions are untenable. If, then, the varved clays were not laid down in lakes ponded by crustal movements off a receding ice front, under what conditions were they deposited? Field examination shows that in the Middletown-Holyoke stretch of the Connecticut Valley only the four or five lowest pairs of terraces carry clays. In nearly every case the clays are overlain by blankets of silt and sand; it is therefore the blankets that form the tops of the terraces. From Middletown in Connecticut to the Holyoke Range in Massachusetts the clay-bearing terraces locally show perfect ice-contact faces. At South Hadley Falls, Mass., a small pit exposing clay appears in one of the mammillary projections of such a slope. Evidently some of the clay was formed in direct contact with the ice (and the rate of melting in this late stage must therefore have been very slow).

Figure 20 is a diagrammatic representation of the relation of the lacustrine terraces to the profile of the Connecticut River. The crosses mark the ideal positions of clay pits in which Antevs measured varved clay sections. The elevations of the pits increase successively northward and expose sections of successively higher terraces. The varves as correlated by Antevs are arranged in overlapping stratigraphic series, higher varves steadily appearing with increasing distance northward.

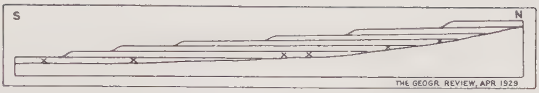

FIG. 20

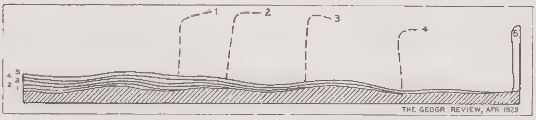

FIG. 21

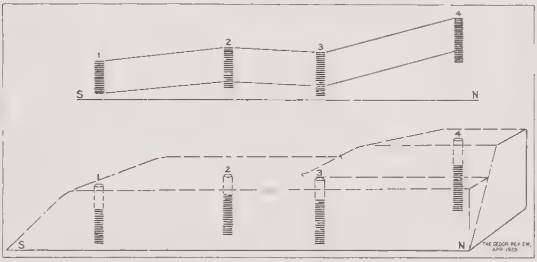

FIG. 22

FIG. 20—Ideal arrangement of terraces in the Connecticut Valley. Longitudinal profile showing the succession of horizontal lake terraces and their relation to the river profile. Crosses mark typical location of varved clay exposures.

FIG. 21—Formation of the varved clays according to Antevs. Five successive varves, numbered roughly to correspond with successive positions of the ice, are diagrammatically indicated as formed in overlapping series during recession of an ice front.

FIG. 22—Correlation of the varves in the Connecticut Valley clays. Above: relative ages in an ideal series, according to Antevs. Below: the same exposures, correlated as required by their relation to the terraces (shown in phantom background) in which they are incorporated. Exposures 1, 2, 3 are correlated as by Antevs, but exposure 4 is in a higher and older terrace.

Antevs, disregarding the succession of terraces, considers that the higher varves are younger, having overlapped the older layers as the "ice front" receded (Fig. 21). In any single vertical exposure the varves obviously decrease in age upward. But exposures show that each terrace characteristically does not run under the next higher terrace but ends against it (Figs. 1 and 22).[32] Terraces at different levels are therefore of different ages—except under special circumstances which are noted later—and the contained clays also must be of different ages. Thus, when the varves are correlated through a distance of several miles from an exposure in a lower terrace to another exposure in a much higher terrace, either the origin of the terraces here outlined is wrong or the correlation of the varves is locally in error.

This argument is not aimed at vitiating the correlation of varves deposited in any one lake. It seeks only to show that some errors have apparently been made in correlating the varves in one terrace with those in a much higher one. Since in general there is no gradational connection between the varve series in successive terraces, probably no continuous and unbroken varve record can be worked out. A minimum number of years could be fixed for the duration of any one lake, however, by counting the varves in the corresponding terrace. Presumably it would be possible also to correlate varves laid down in separate but contemporaneous lakes in adjacent valleys, as, for example, the valleys of the Hudson and the Connecticut.

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[32] This does not controvert the fact that the clays commonly run under sand. The clay and sand in any vertical section together form one integral terrace.

The fact that the varved clays grade upward through silt into sand in some exposures and are disconformably overlain by coarser material in others is readily explained by the stagnation of the ice (Fig. 23). It has been pointed out that in some places the ice shrank away from the valley walls faster than sediment could be built out against the receding ice margins, so that the corresponding terrace faces were essentially delta fronts rather than ice-contact slopes. This situation obtained only in the lower terraces. It was apparently the result of general decrease in gradient as base level was approached, causing the introduction of less and less material into the marginal basins. As the ice margins drew away from the coarse terrace faces, deep alleys were opened in water of constant depth in which fine suspended clay particles settled out, grading locally into silts. The uncovering of a lower notch to the south would open a new spillway, the lake surface would drop immediately to the new lower level, the coarse terrace material would emerge, and the water in the alleys of clay deposition would suddenly shoal. If the shoaling was slight, the clays would soon be overlain with silts; if great, the topmost clays would be eroded by the scour of the currents in the new lake and sand would be laid upon them. The degree of change in sedimentation would thus vary from place to place, as in fact it is observed to vary, depending on the thickness to which the clays had been built up before the change came and the amount of sudden change of level of the lake. This being true, it follows that a given section of clay was not necessarily laid down in water at the level of the terrace of which the clay now forms a part. It may be correlated with the next higher or possibly even the second higher terrace (Fig. 24).

Stagnation in Relation to Glacial and Postglacial Changes of Level

"During the greatest extent of the last ice sheets and the early days of waning, the sea level stood considerably lower than at present, because large quantities of water were locked up in ice. At the climax it probably was some 300 feet (90 m.) lower."[33] What the exact

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[33] Antevs, The Last Glaciation, p. 83.

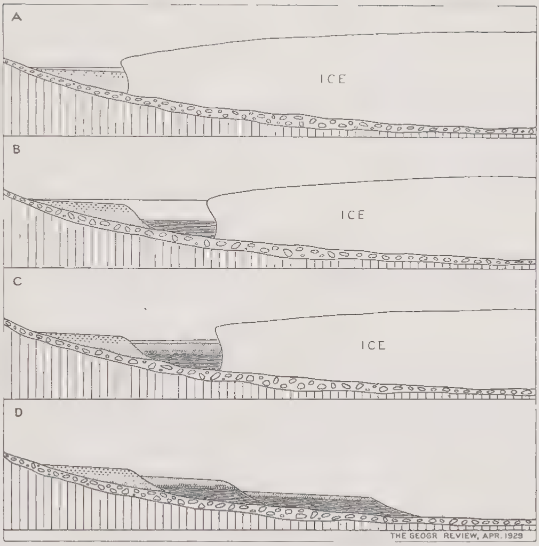

FIG. 23—Origin of the relationship between varved clays and overlying sand. Diagrammatic transverse section through half of a valley in which marginal lacustrine terraces are forming. A, high terrace of sand and gravel rapidly accumulating. B, rate of shrinkage of ice margin exceeds outbuilding of terrace; clays deposited in deep water. C, lake level drops in sympathy with the opening of a lower spillway, and silt and sand are successively deposited upon the clays in the newly shallowed water. D, postglacial relations: the clays in the lowest terrace were deposited just as in the second, but the later lowering of the lake decreased its depth so much that the clays were slightly eroded before being covered with coarse sand. The nature of contact and overburden thus depends on the vertical distance between successive lake levels.

figure was is not germane to the present argument. On theoretical grounds it seems necessary that the late-glacial sea level was lower than the level of the modern sea. Contributory evidence of a lower stand of the sea in the Connecticut region has been advanced. The presence of glaciolacustrine sediments filling valley bottoms 20 to 30 feet below present sea level may be cited in additional evidence. The ria shore line of Connecticut and the partial submergence of the Cretaceous cuesta of Long Island may have been caused solely by a postglacial eustatic rise of the sea. It is even possible that the final disappearance of residual ice from the Sound depression was brought about by flotation as the depression became gradually flooded by the rising sea. Cook has suggested[34] that the ice in the St. Lawrence trough may have been floated by the marine incursion there. Both suggestions are, however, mere speculation.

Rise of the sea is not the only postglacial change of level that has been urged for southern New England. Several investigators, notably Woodworth,[35] Fairchild,[36] Goldthwait,[37] and Antevs,[38] have stated their belief that the region of southern New England, including Connecticut, was differentially uplifted at or after the "recession" of the "ice front," so that the northern parts of the region today stand higher than the southern parts with reference to a horizontal datum. The evidence on which Fairchild based his conclusions has been reviewed by the present writer and shown to have been misinterpreted.[39]

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[34] *Op. cit.*, p. 160.

[35] J. B. Woodworth: Ancient Water Levels of the Champlain and Hudson Valleys, *New York State Museum Bull. No. 84*, 1905.

[36] H. L. Fairchild: Pleistocene Marine Submergence of the Connecticut and Hudson Valleys, *Bull. Geol. Soc. of America*, Vol. 25, 1914, pp. 63–65 (abstract), 219–242.

Idem: Post-Glacial Uplift of Southern New England, *ibid.*, Vol. 30, 1919, pp. 597–636.

[37] J. W. Goldthwait, in Antevs' "Recession of the Last Ice Sheet in New England," pp. 104–107 and map.

[38] Antevs, The Last Glaciation, pp. 83 ff. and Fig. 1.

The Hudson Valley relationships on which Woodworth based his statements have not been examined in detail by the writer and therefore will not be reviewed here. It may be said, however, that a reconsideration of Woodworth's evidence in the light of the conception of stagnant ice offers a different interpretation of his discontinuous "warped water planes," namely as deposits in marginal lakes similar to those in Connecticut. Goldthwait constructed isobases only for southeastern New Hampshire and the adjacent part of Massachusetts, from observations and measurements made in the field. Antevs extended these isobases southward and westward and stated that the whole region had suffered a differential tilt that increased in strength toward the north.

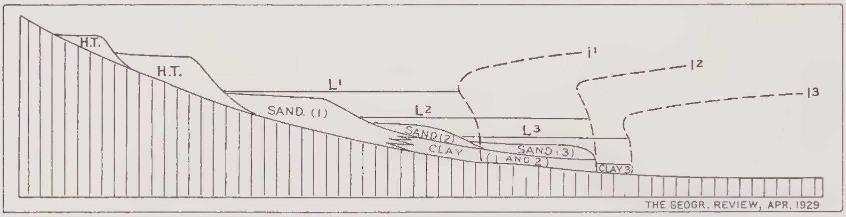

FIG. 24—Conditions under which clays in two successive terraces could be contemporaneous. Diagrammatic transverse section through half of a valley with marginal lacustrine terraces. I^1, I^2, I^3 = successive positions of ice margin. L^1, L^2, L^3 = successive levels of marginal lake. H.T. = higher marginal lake terraces. The numbers in the lower terraces indicate the lake levels with which the various deposits are associated. The relations are such that clay is deposited continuously throughout the later history of L^1 and the entire duration of L^2. During L^2 and I^3, Sand (2) and Sand (3) are deposited above the continuous clay, forming two distinct terraces at the surface with a common substructure of clay.

In an earlier paper[40] the writer argued that the horizontality of the extensive lake-controlled terraces in the Connecticut Valley in Connecticut and Massachusetts is strongly opposed to the theory of postglacial tilting so far as the immediate area of the valley is concerned. To this evidence may now be added the fact that throughout Connecticut, in every valley, horizontality of the flanking terraces of strictly lacustrine origin is universal. This statement is based on detailed tracing in the field, with all elevations tied to near-by bench marks recently established by the U. S. Coast and Geodetic Survey.

It is well known that northern New England, perhaps as far south in the coastal region as Cape Ann, has been affected by differential postglacial uplift. No conclusive evidence of such uplift in southern

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[39] Flint, Pleistocene Terraces of the Lower Connecticut Valley, pp. 216–217.

[40] *Ibid.*

New England has been advanced. The evidence cited above points to no uplift in Connecticut and south-central Massachusetts at least. As far as our present knowledge carries us, then, it would seem that the hinge line or zone of initial uplift must lie at least as far north as central Massachusetts.[41] It would not be difficult to establish this point by means of a detailed survey in the region in question.

Stagnation in Other Regions

A consideration of the stagnation phenomenon leads naturally to the question of its total areal extent. Through how wide a region did the last ice-sheet cease to behave as a live, actively streaming mass? The field criteria outlined in the preceding pages are not difficult to recognize. In addition to detailed field study in Connecticut, the writer has carried reconnaissance into Rhode Island and southeastern Massachusetts, into central Massachusetts north to the Vermont line, and into New York east of the Hudson. It may be stated unequivocally that these areas were included within the limits of the stagnant ice. It has been shown that Salisbury's work indicates that stagnation also occurred in northern New Jersey. Study of the topographic maps of northern New England shows precisely the same marginal terraces and the same channels and notches in the bedrock surface that exist in Connecticut. Stagnation almost certainly affected this entire region as well.

Cook[42] was the first to point out the probable great extent of stagnation. His argument has not received sufficiently wide publicity and is freely referred to here. The region investigated by Cook lies in eastern New York along the Hudson Valley, where the phenomena indicative of stagnation are well developed. The distribution of recessional moraines, however, suggests a far greater extent for the stagnant part of the last ice sheet. The looped recessional moraines of the Erie Basin extend eastward into the region south of Lake Ontario. But one by one they disappear; east of Syracuse the only feature referred to as "recessional moraine" by Goldthwait[43] is a continuation of the "Finger Lakes Moraine," or "Valley Head Moraine," which scarcely resembles the recessional moraines of the Middle West and may be only a series of accumulations of débris washed over stagnant masses of ice and banked against the steep heads of the valleys that drain the Allegheny escarpment. East of Utica even this accumulation disappears.[44] This disappearance of recessional morainic deposits, taken in conjunction with the positive evidences of stagnation in southern New England, New Jersey, and adjacent New York, strongly suggests that the latest ice in the east lost its motion while most of the ice farther west continued its active motion as it was being melted back and that the boundary zone separating the live ice from the dead ran southward from the eastern end of Lake Ontario. Cook[45] considers it possible that here and there, as in the Hudson Valley, live ice locally "streamed" through the stagnant mass, causing restricted thrusting effects. No such effects are evident in Connecticut, and none has been observed in adjacent regions.

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[41] Professor C. R. Longwell has suggested that since the lakes that built the continuous (lower) terraces were associated with the late stages of dissipation, during which but little ice lingered on the surface, postglacial crustal movements may have occurred and the crust become adjusted prior to the formation of these terraces. The objection that the time allowable for adjustment would have been too short, when compared with adjustment in other regions, is weakened by Fuller's correlation (Geology of Long Island, table opposite p. 220) of the Long Island moraines with the Early Wisconsin stage. If this correlation is correct (there is no evidence in Connecticut to prove or disprove it), the dissipation process in New England may have occupied considerably more than half of the entire Wisconsin epoch, in which case the hypothesis of pre-terrace crustal adjustment is strengthened.

[42] *Op. cit.*

[43] Goldthwait, in Antevs' "Recession of the Last Ice Sheet," p. 106.

In Minnesota, to the north of the looped recessional moraines of Illinois and Wisconsin, there are two broad areas of stratified sands and gravels each pitted with hundreds of great kettles in chains and groups, with infacing ice-contact slopes. Topography typical of these areas is shown on the Battle Lake, Fergus Falls, Pelican Rapids, Perham, and Vergas (Minnesota) quadrangles. The component material is mapped by Leverett and Sardeson[46] as "sandy moraines" and "outwash gravel."

Marginal terraces with crevasse fillings much like those in southern New England have been observed in the Yakima Valley in Washington.[47] They are briefly described in the Snoqualmie and Mount Stuart Folios,[48] where they are referred to as stream terraces excavated from a mass of outwash material that formerly filled the valley from side to side. The presence of crevasse fillings in association with the terraces does not admit of this interpretation but points to stagnation of the mass of ice that formerly filled this portion of the valley. Similarly, the topographic maps covering Okanogan County, to the northeast, show extensive horizontal terraces and abandoned spillways in profusion. The relations exhibited suggest that stagnation may have affected the latest ice in that region as well.

CAUSE OF STAGNATION

If the Minnesota and Yakima Valley relations are to be explained on a basis of stagnation, a common cause must have operated to bring about loss of motion in the areas of ice involved.

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[44] These relations are brought out on a map in Antevs' "The Last Glaciation," Fig. 29, p. 164.

[45] *Op. cit.*, p. 168.

[46] Frank Leverett and F. S. Sardeson: Map of the Surface Formations of Minnesota, *Minnesota Geol. Survey and U. S. Geol. Survey*, 1916.

[47] Personal communication from Aaron C. Waters.

[48] G. O. Smith and F. C. Calkins: Snoqualmie Folio, Washington, *Geologic Atlas of the United States No. 139*, U. S. Geol. Survey, 1906, p. 13 and map.

G. O. Smith: Mount Stuart Folio, Washington, *Geologic Atlas of the United States No. 106*, U. S Geol. Survey, 1904, p. 8 and map.

Cook has stated his opinion[49] that stagnation was the result chiefly of subsidence of the crust under the weight of the ice sheet. He argues that subsidence reduced the slope down which the ice was flowing and caused stagnation in the regions of greater relief where movement would be most effectively impeded. The present writer independently reached the conclusion that topography was the local and immediate cause of loss of motion in parts of the last ice sheet. When Cook's statement is examined in the light of present knowledge concerning postglacial uplift in northeastern America, it appears inadequate as a factor controlling ice movement. The highest estimates of uplift in the southern St. Lawrence region are of the order of 500 to 600 feet. If this region were tilted back to coincide with the supposed glacial datum plane, with a hinge line even as far north as northern Massachusetts, the resulting land surface would not be a reverse (north-facing) slope. But, even if the slope were gently reversed, the fact remains that the maximum uplift amounts to only about one-tenth of the maximum relief (5000 to 6000 feet) and to perhaps one-fourth of the average relief of the extensive New Hampshire-Vermont-Adirondack region over which the ice had to pass. It seems clear that the major topographic control was exercised by the preglacial configuration rather than by glacial crustal subsidence.

The relations in the Yakima Valley referred to in the preceding section nevertheless seem to indicate that stagnation may be brought about without crustal movement. The ice in this valley proceeded from a local glacier of the alpine type with three tributaries, each heading in a cirque.[50] The valley, two to three miles wide through the ten-mile reach between Kachess Lake and Nelson, suddenly narrows at Nelson to a width of one mile. Widening again below Nelson through another ten-mile stretch, it narrows sharply to a gorge at Teanaway, below which the valley is not glaciated. Throughout these reaches the gradient is markedly less than in the upper valley.

The marginal terraces suggestive of stagnation occur in the broad stretches. In these sections recessional moraines are not indicated. It seems probable that the living glacier, having pushed its tongue far down toward the gorge near Teanaway, was unable to maintain its motion through the narrows above. The lower part of the ice would then be left as a great bulb not unlike the spread-out mass of the modern Malaspina Glacier. The former marginal escape of water is indicated not only by the relic terraces but by spillway channels similar to those in New England.[51] Small valleys in the vicinity, also occupied by Pleistocene alpine glaciers but lacking conspicuous broad reaches and narrows, indicate by the presence of looped recessional moraines that their glaciers retreated normally without losing motion. It appears probable then that stagnation in this region was controlled chiefly by topography.

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[49] *Op. cit.*, pp. 159–160.

[50] Smith and Calkins, *loc. cit.*

[51] *Ibid.*

Applying the same principle to the areas of known and probable stagnation in the East (Fig. 25) we find that they are coincident with regions of notably great and abrupt relief or that they lie in the lee of prominent relief features. In and south of the Adirondacks and throughout New England the ice stagnated probably because the intricately dissected mountain barriers offered to glacier movement a resistance that in the waning stage could not be overcome. The St. Lawrence-Lake Ontario ice, however, was able to maintain its motion sufficiently to build normal recessional deposits in the lowland north of the Allegheny escarpment. It can scarcely be fortuitous that recessional moraines eschew the rough country. The only open gateway through this region is afforded by the Hudson-Champlain trough. Here Cook has found evidences of possible streaming through the stagnant field of ice.[52]

The Minnesota areas in which stagnation is suggested lie in the lee of the highlands, including the Giants Range, northwest of Lake Superior. The Okanogan County region in Washington is one of great and abrupt relief. Although the relationship between these positions and the apparent stagnation of the ice cannot be proved in the present argument, the coincidence is suggestive.

Topography may not have been the ultimate cause of stagnation. The assumption that the last ice sheet overtopped all the mountains of the New England-Adirondack region seems well founded. It is not unlikely that a more fundamental cause operated to weaken the thrust of the whole glacier mass, thus permitting local topographic barriers to exercise an effective restraining influence.

Brooks has argued[53] that slight ultimate causes produce great immediate extensions of continental ice sheets, that advancing glaciers operate vigorously to extend themselves by a complicated gearing-up system, and that receding glaciers shrink at the same geared-up pace. If this is true, it is not difficult to conceive that an ameliorative climatic change that occurred while the last ice sheet was at its maximum extension would so reduce the active thrust from its center that the enfeebled periphery, already thinned by ablation, must respond at once by stagnating in those regions where great topographic barriers raised the friction ratio and reduced the ease of ice movement. That the widespread cause involved increased wastage rather than decreased alimentation is at least suggested by the fact that the stagnation phenomenon appears not to have been confined to one center of ice dispersal but to have affected the Labrador, Cordilleran, and perhaps the Keewatin centers at approximately the same time.

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[52] *Op. cit.*, p. 168.

[53] C. E. P. Brooks: Climate Through the Ages, London, 1926, Ch. 16.

The discussion of immediate topographic control set forth above opens an interesting speculation as to whether the pre-Wisconsin ice sheets were not affected by the same barriers and did not therefore dissipate in the same unusual manner.

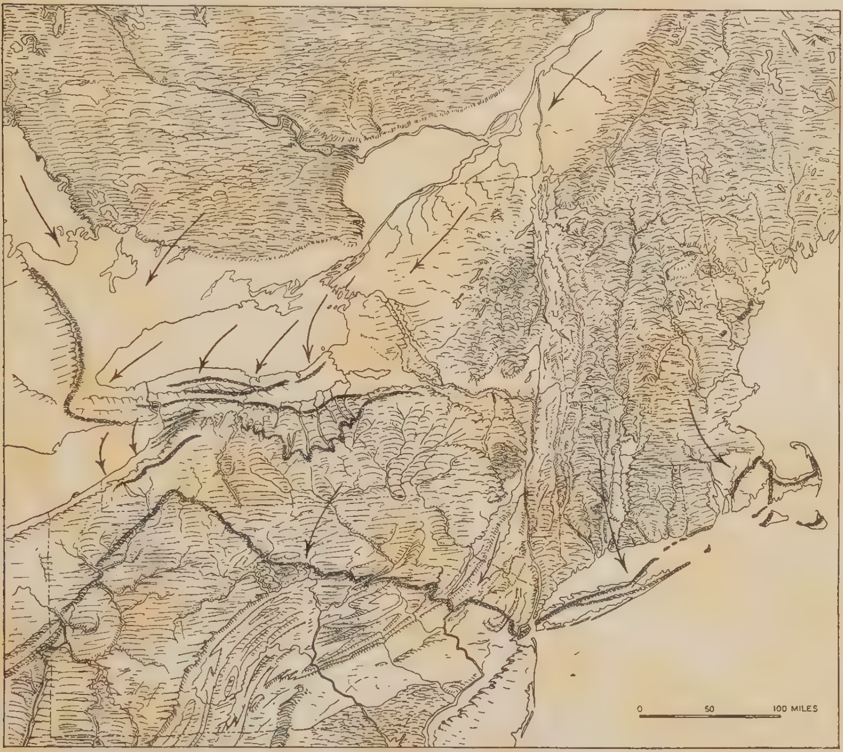

FIG. 25—Diagram of New England and the eastern Great Lakes region showing Wisconsin terminal moraine, extent of recessional moraines, and principal directions of ice movement. Area of stagnation in the last ice sheet probably includes all of New England, eastern New York, northern New Jersey, and northeastern Pennsylvania, extending west nearly to the Finger Lakes district.

Base after A. K. Lobeck. Direction of ice movement after T. C. Chamberlin. Moraines after J. W. Goldthwait and Leverett and Taylor. The data from Goldthwait are modified as explained in the text.

In conclusion, the need for careful discrimination between glacial land forms caused by normal ice retreat and those caused by stagnation must be stressed. Prejudice has not infrequently affected field studies in the eastern part of the glaciated region. Ice-contact slopes have been mistaken repeatedly for normal delta fronts. Pitted lacustrine terraces, marginal glaciofluvial terraces, and groups of related crevasse fillings have been commonly mistaken for terminal and recessional moraines. The abundant spillway channels have been almost ignored. Future investigation carried on with the criteria of stagnation in mind will add greatly to our accurate knowledge of the dissipation of the last ice sheet.

THE QATTARA POWER SCHEME

H. Sirry Bey
Survey of Egypt

A NEW hydro-electric scheme for generating power by the continuous admission of sea water from the Mediterranean with a considerable fall into a natural depression in the Libyan Desert called Qattara, is now being carefully investigated by the Survey of Egypt.

THE QATTARA DEPRESSION

This depression, whose existence was unsuspected until quite lately and which might still have remained undiscovered but for the strenuous efforts made by the Survey of Egypt during the last few years to extend accurate triangulation surveys far from the Nile Valley into the inhospitable wastes of the Sahara, is an enormous hollow in the northern part of the Libyan Desert, in which some 7000 square miles lie below sea level. The eastern end of the depression approaches to within about 80 miles of Alexandria, 130 miles of Cairo, and 40 miles of the Mediterranean coast. Its deepest point is 440 feet below the level of the Mediterranean, and even the contour of 160 feet below the sea level embraces an area of some 4000 square miles. If a lake were to be formed within the depression with its surface at this last-named contour, it is easy to show that, on the assumption of a mean daily evaporation of one-sixth of an inch from the lake surface, sea water might be passed continuously into the depression at the rate of some 40 million tons a day, with a total fall of 160 feet, without altering the level of the lake; and the energy of the falling water might be used for power generation. The water of the inland lake would, of course, gradually become more and more saline, since salt would be continuously passing into it from the sea while only pure water would be disappearing from it by evaporation; but the volume of water in the lake would be so vast that it would require centuries for the accumulation of salt to become great enough to interfere seriously with the rate of disposal of the influx by evaporation.

POTENTIAL POWER ESTIMATES

Allowing for losses of energy in the conduits, generators, and transmission, it is estimated that a continuous net output of some

160,000 horse power could be distributed in Lower Egypt by utilizing the influx for power production. The total consumption of power at the present time in Lower Egypt for all purposes (railways, tramways, lighting, mills, etc.) is but a small fraction of the power obtainable from the Qattara Depression. Even on the most liberal estimate of the increased power consumption which may be required for the above purposes during the next century, including pumping on a large scale for the reclamation of the two million acres or so of land as yet uncultivated in the northern parts of the Nile Delta, it is estimated that the carrying out of the Qattara Scheme would more than satisfy the demands and would leave a surplus of power for the development of new industries in Lower Egypt. The scheme, if it can be carried out at not too high a cost, will therefore meet two of the greatest needs of Egypt, namely a large increase in the cultivable land area of the country in order to accommodate her ever-increasing population, and a source of power within her own borders for the development of new industries. The Qattara Scheme would, in fact, accomplish for Lower Egypt what the Aswan power scheme is intended to do for Upper Egypt; the two schemes are complementary.

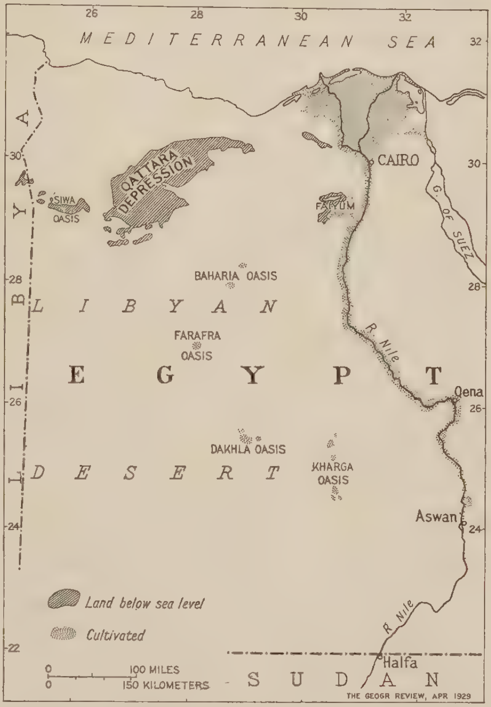

FIG. 1—Sketch map to show the Qattara Depression. Scale 1 : 13,500,000. The Depression is shown on a scale of 1 : 1,000,000 in new "Atlas of Egypt" (reviewed in this number of the *Geogr. Rev.*).

INVESTIGATIONS IN PROGRESS

Whether the Qattara Scheme will prove to be economically practicable will depend, of course, largely on the costs that would be incurred in carrying it out; these costs cannot be even approximately estimated until the results of the detailed investigations now in progress are known.

The sloping plateau that separates the depression from the Mediterranean attains such considerable altitudes over most of its breadth of 40 miles, that the excavation of open canals to conduct sea water into the depression is out of the question. The aqueducts will therefore have to be tunneled for the greater part of their length; and one of the principal lines of investigation is that directed towards the ascertaining by trial borings of the exact nature of the rocks through which the tunnels would have to be driven. Simultaneously with the boring operations in the tract between the sea and the depression, detailed contour surveys are being conducted both within the depression itself, to ascertain its exact content for different levels of the proposed lake, and in the tract between the depression and the delta to ascertain the best route for the transmission of the power to be obtained. Careful experiments are being made to ascertain as accurately as possible what is likely to be the rate of evaporation from an open surface of salt water within the depression, also how this rate is likely to vary as time goes on with increasing salinity of the lake, and as to the nature and amount of salts likely to be precipitated in the course of centuries.

It is hoped that within two years the investigations will yield sufficient data to enable the probable costs of the scheme to be approximately ascertained and a judgment to be formed as to its economic practicability.

NOTE ON THE MAP OF THE HUALLAGA GORGE BETWEEN HUANUCO AND MUÑA

O. M. Miller

American Geographical Society's School of Surveying

THIS map of a section of the Huallaga River is supplementary to the writer's article on "The 1927–1928 Peruvian Expedition of the American Geographical Society," which appeared in the January, 1929, number of the *Geographical Review*. It covers the portion of that great tributary of the Amazon, between the town of Huánuco and the village of Muña, where the river flows transversally across the mountains from west to east. At Muña the Huallaga resumes its northward direction.

The chief points of interest to be noted in the map are the depth of the gorge itself, 5000 feet at Huánuco and more than 7000 feet in the neighborhood of Muña, and the remnants of the former deep alluvial fill.[1] In connection with the latter, note especially the high alluvial terrace to the southwest of Huánuco, also its effect on the topography in the steep side quebradas all the way down the gorge. Near Acomayo it should be noted that the river has sunk much farther below the level of the alluvial fill than at Huánuco. Below this there is practically no trace of the alluvial fill until Piedra Grande is reached, the river flowing through a narrow precipitous gorge; but to the south of Piedra Grande are high cliffs on the top of which are level areas protruding out into the gorge.

An extremely interesting feature of the region covered by the map is the sharp dividing line between the montaña and the semiarid zone. It cuts across in an almost straight line in a direction approximately parallel to the main cordillera, about 70 miles to the west. The hills in the immediate vicinity of Chaglla are bare of trees, as is all country to the west; but on the other side of the gorge to the northeast the hills are wooded to their summits, and the mountains at Tambo de Vaca are also forested. Clouds almost continually lie over the summits of the latter.

CONSTRUCTION OF MAP

A base of more than 1300 meters was measured along the straight street in Huánuco which leads to the bridge over the Huallaga. From both ends of the base points were intersected. The next station

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[1] Compare the map, Figure 29, the gorge at Huánuco (scale 1:42,000), and the sketches of alluvial terraces, Figures 30-32, in the writer's previous paper.

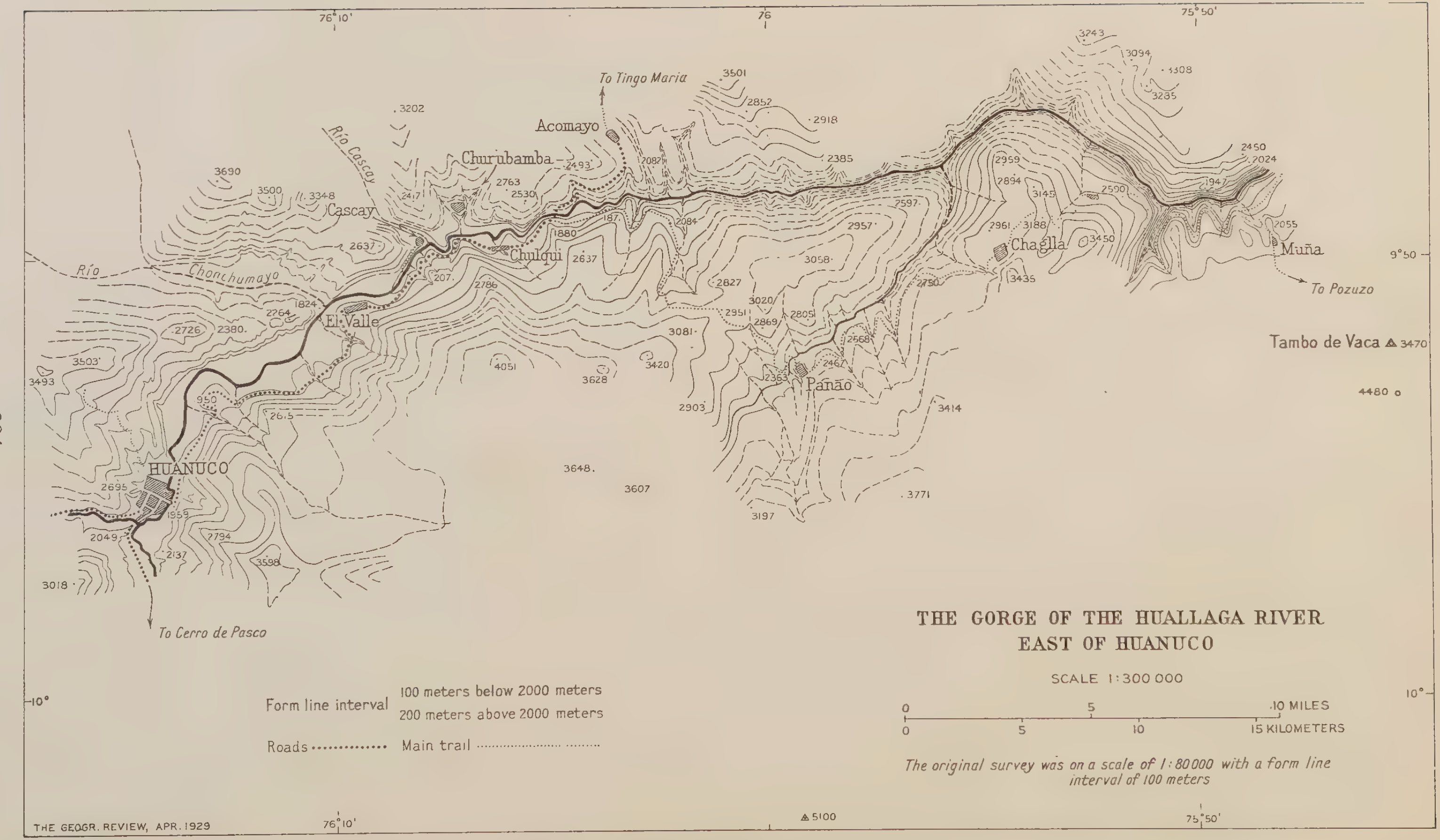

Fig. 1—Map of the Huallaga gorge between Huánuco and Muña.

occupied was located by resection from these intersected points. Rays to other prominent points were then observed. This process of intersection and resection was continued down the river as far as Muña and together with two astronomical stations, one at Huánuco and one at Tambo de Vaca, forms the control of the map. The datum level (1930 meters) was assumed at the bridge of the Huallaga at Huánuco and is in comparatively close agreement with the height of Huánuco as determined previously on several occasions by barometric observations. Differences of level were all determined trigonometrically and also agree well with aneroid observations made by other travelers in this region.

Only the approximate positions of the mountains above Tambo de Vaca were determined, owing to the fact that they were almost constantly in cloud. Their heights, found from vertical angles observed from the southeast at the astronomical station at Cushi, must be accepted with reserve. However, they agree approximately with those found by an engineer named Tucker, who did a route traverse across this range some years ago.

In the trigonometrical work, the principal instrument used was a Wild theodolite. Horizontal angles were read only to the nearest minute of arc; and it should be noted that, though the Wild instrument is capable of reading to the nearest second of arc, it is much less trouble to read approximate angles with it than to read them with an ordinary engineer's transit. This method of skeleton triangulation has a great many advantages over a traverse in open country, the most obvious being that it is not necessary to have consecutive stations visible one from the other.

The topography has been drawn from numerous sketch maps and perspective drawings made by the writer.

THE SECOND CONFERENCE ON CYCLES

A SECOND conference on the problem of cycles was convened by President Merriam of the Carnegie Institution at Washington on December 15, 1928. Thirty-five scientists were present with Dr. D. T. MacDougal of the Institution's Division of Plant Biology in the chair. The purpose of the meeting was discussion of new material accumulated since the first conference held in December, 1922.[1] An abstract of the proceedings is here presented.

Introduction

PRESIDENT MERRIAM, introducing the chairman, referred to the accumulating evidence of cycles indicative of certain questions which must be solved. The discussions to take place here, he said, will be related to our several types of special interests. Some will consider the matter from the point of view of tree growth; others will be interested in the problem as it relates specifically to solar radiation. The first question to be considered concerns the influence of outside physical factors on the growth of trees. In consideration of these factors we realize the importance of variation in climate as involved and hope that, through study of the influences as we see them expressed, the growth of the tree from year to year may ultimately be sufficiently understood so that the data available may help us to understand the climatic conditions under which trees have formed in past periods.

If there could be agreement in a general way regarding the principles involved in a discussion of cycles, we should have a starting point for what seems one of the most significant studies of interrelation of scientific factors in the whole field of science. If, on the basis of study of relation of existing physical factors to development of tree growth, we could define a measuring rod for climatic change, this same measure could probably be used for remote periods. There would then be not only the expectation of determining what the local climatic conditions were but the further possibility of forming some estimate as to the nature and rate of changes in the sun.

In our discussion it will be worth while to ascertain as clearly as may be possible not only where the points of agreement lie but to discover as well the nature of the differences which separate the several groups of students of this subject.

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[1] Report of a Conference on Cycles, *Geogr. Rev. Special Suppl.*, Vol. 13, 1923, pp. 657–676.

Trees as Recorders

DR. MACDOUGAL summarized some of the results of his dendrographic records begun in 1918. The dendrograph makes a continuous record of the variations of the diameter of a tree between two contact points on opposite sides of the trunk. The Monterey pine (*Pinus radiata*) and the coast redwood (*Sequoia sempervirens*) were selected for discussion. Records are available for 31 pines for a period of 1 to 10 years and for 16 redwoods for 1 to 5 years. Both trees live in the coastal region with an equable climate due partly to the recurrence of fogs (maximum temperature in May or September-October) and with a rainfall averaging 450 millimeters, mostly from November to April. In addition to recording actual conditions experiments were undertaken to simulate natural but unusual phenomena—thus irrigation during the dry season.

The activity of the redwood was found to be conditioned primarily by soil water supply with some influence by fogs. Correlation between total growth and total rainfall was less than in the case of the pine.

Next to water supply temperature of the cambium must be of the greatest importance. As yet no practicable method has been devised for continuous registration. Three hundred readings, however, were taken on a redwood in 1926–1928. Plotted, they correlate well with the growth curve. In fact the annual layers would seem to record the course of temperature more nearly than that of rainfall in the years recorded. The possibility of using certain trees as recorders of temperature and of others as recorders of rainfall greatly increases the prospective value of the trees as an indicator to students of past climates.

The use of X rays may also be expected to aid in deciphering many features of the layers otherwise not easy to read.

Cycles in Tree Growth: The Cyclograph

DR. A. E. DOUGLASS, Director of Steward Observatory, University of Arizona, described a check made on the study of cycles in trees. Observations have recently been conducted on 305 trees taken in 42 groups over the western area between the eastern edge of the Rocky Mountains and the Pacific and between the Columbia River and the Mexican border. The area was divided into Coast, Arizona, and Rocky Mountain zones, with about 17,000 ring measures to the zone. In 1926 three complete analyses were made of the group curves; the cycles were plotted in periodogram form and published. A replotting was then made on scales unknown to the author and re-analyzed. Dr. Douglass found agreements sufficiently strong to give evidence of the reality of the cycles. There was furthermore a strong resemblance between the zones with some difference in emphasis. Combined into one curve they give considerable expectancy that the western tree cycles are closely related to the Brückner cycle and therefore to solar variations.

Referring to long records in annual rings, Dr. Douglass instanced the four three-thousand year sequoias now known, three in a grove east of Springville and one, the oldest, 3233 years, near the General Grant National Park. The record in these trees is clear, and its appearance in similar form throughout the sequoia area indicates a close climatic connection. There is strong evidence that precipitation plays an extremely important part; but other factors enter, and interpretation of the record will be more complex than for the yellow pine of Arizona. Up to the present time the coast redwood has not been found to be its equal. In two selected groups of the coast redwood, in northern and southern California respectively, not enough similarity obtained among different trees to warrant the belief that climatic effects were being recorded. Further effort will be made to find coastal redwoods that show climatic effects.

The western yellow pine, flourishing in a much drier region, gives more direct record of rainfall. Excellent records go back 500 years, one 640 years. Supplemented by early historic and prehistoric material, the pine records cover some 1255 years—divided, however, by a gap of unknown duration. The series will be of the highest value when this gap can be filled.

Dr. Douglass also reported on progress made in the technique of cycle measurement. Since 1914 he has undertaken search for periodic characters in curves of rainfall, tree growth, sunspot numbers, and other data by a cyclograph method specifically developed for the purpose. The improved form of the instrument, the White cyclograph, which has a range from a minimum cycle of 6 years or less to a maximum of over 42 years, is described and illustrated in "A Study of the Annual Rings of Trees in Relation to Climate and Solar Activity."[2] By a device introduced in 1928 it becomes a direct-reading, variable-grating cycloscope.

In answer to a comment on varying periods, raised by PROFESSOR C. F. MARVIN, the capacity of the cyclograph to show variable and broken cycles as well as constant ones was emphasized.

MR. H. H. CLAYTON remarked that in his long study of cycles the most serious difficulty he had encountered in analyzing solar and meteorological cycles was the rapid variation in amplitude and occasional inversion of phase that was exhibited. In most methods used in physics and astronomy—in the analysis by correlation formulas used by the speaker, Abbot, and Alter, and in the cyclograph analysis used by Douglass—constancy of phase was assumed. Change of phase does not necessarily prevent the discovery of the cycles by these methods but greatly reduces the amplitudes of the periods found and renders futile any efforts at forecasting from the data.

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[2] A. E. Douglass: Climatic Cycles and Tree-Growth, Vol. 2, *Carnegie Instn. Publ. No. 289*, 1928.

Life Cycles in Disease

Dr. W. C. White, Chairman of the Medical Division of the National Research Council, pointed out that much evidence relates diseases in both men and animals to certain well known cycles in nature. The study of disease cycles has not yet been brought into relation with the great cycles of nature such as those occurring in the great cosmic cycles or even to the sunspot cycle. We have, however, evidence of such a relation in rickets, in which disease we can trace the influence of various wave lengths of the sun and its emanations on the definite chemical substance known as sitosterol. These emanations occur in cycles of intensities.

Most prominent cycles with which diseases are associated are seasonal cycles in the so-called infectious diseases. Some, as far as man are concerned, are due to cycles of other forms of life, e.g. Rocky Mountain spotted fever. In others we are yet ignorant of the cause of the cyclic appearance. We know practically nothing of the life history of many of the infectious micro-organisms outside the body. A plan for the study of such organisms in the soil has lately been presented to the Division of Medical Sciences of the National Research Council in coöperation with the Department of Agriculture and the Public Health Service. A significant example of the influence of the various stages in the cycle of the organism itself is seen in malaria in man in the quotidian, tertian, and quartan fevers. There are evidences of much greater cycles in other diseases to which we as yet have no clue, which may explain their epidemic character. Probably many of the diseases from which we suffer cannot be controlled until our knowledge of the various cycles is complete.

Solar Cycles

Dr. C. G. Abbot, Secretary of the Smithsonian Institution, observed that when the first of the cycle conferences was held he had not been greatly impressed with their solar aspect but that he now was somewhat more sanguine. He pointed out the uniformity of Hale's 22.6-year period applied to sunspot minima. The year 1946 may certainly be predicted as a year of sunspot minimum and whatever terrestrial phenomena are associated with it. For maxima there is not such great uniformity, but indications point to a sunspot maximum about 1929.

Associated with the sunspot cycle there seems to be a fluctuation of the emission of solar radiation. Knowing the probable march of sunspots, we may trace that of solar radiation. Developments of the last two years lead us to hope that we can go much farther.

In 1926 Dr. Abbot discovered a tendency to a regular pulse of slightly more than 2 years in the solar constant values for 1920–1926.

Analysis confirmed the period as 2.14 years and also revealed pulses of 1.28 and 0.91 year. On this basis he forecast an appreciable maximum of solar constant values about May, 1928, and very decided minimum about November, 1928, both of which were verified. Several meteorologists have discovered evidences of terrestrial periodicities closely approximating those of about 11, 15, and 25–26 months, D. Brunt, for instance, in an analysis of meteorological data from certain European cities.[3] De Geer also has noted a period of about 2 years in studies of the advance and retreat of glaciation; and the Department of Agriculture in the yield of food crops.

Spectroscopic studies of atmospheric ozone now under way suggest another connection between solar and terrestrial events.

Mr. H. H. Kimball, commenting on Dr. Abbot's paper, observed that sunspot numbers and solar constant values for the last 11-year cycle did not indicate a close relation and inquired as to whether there was such a relation in the 26-month and shorter cycles to which Dr. Abbot had referred.

Dr. Abbot in reply attributed discrepancies to two causes: first, that solar radiation rises to a maximum with medium sunspot numbers and declines thereafter as sunspot numbers increase; secondly, that superposed on the sunspot influence on solar variation there appear to be three pulses of regular periods of about 25, 15, and 11 months respectively, and of amplitudes which are large enough when combined in similar phase nearly to overpower the maximum sunspot effect on the solar constant values.

Mr. H. H. Clayton remarked that the 25-month cycle had been discovered by him in meteorological phenomena more than 40 years ago and described in two papers published in the *American Meteorological Journal* in August, 1884, and April, 1885, respectively. A period of nearly the same length in sunspots was described by Dr. Douglass in 1921.

Cycles in Variations of Glaciers and Ice Sheets and in Ice Melting

Dr. Ernst Antevs called attention to the large amount of material available on the variations of glaciers and ice sheets and on the melting of the Pleistocene ice sheets, material which promises to shed much light on the periodicity of climate during the last 35,000 years. He gave illustrations of cycles in the variation of modern glaciers—noting that not all glaciers are suitable for study, for not all respond promptly to meteorological change—and of variation in the Pleistocene ice sheets recorded by moraines and of melting recorded in the varved glacial clay. While the rate of the ice retreat is especially suited for the study of long-range periodic phenomena, the varve graphs are best suited for the study of short cycles.

Perhaps the most important results so far obtained from the analyses of the varve curves is the almost complete absence of the 11-year cycle in the curves studied by C. E. P. Brooks.[4] The nearest approach to an 11-year periodicity is one of 10.4 years in a varve series from Argentina, but even this has nothing of the compelling rhythm of the modern sunspot curve. In curves from Argentina, Brooks also found periodicities of 5.1 and 51 years. In varve graphs from North America periods of 2, 3, 4, 5, 6, 7, and 8 years have been determined by Köppen,[5] the period of 2 years being found in 125 cases, that of 8 years in one case.

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[3] *Quart. Journ. Royal Meteorol. Soc.*, Vol. 53, 1927, pp. 1–30.

[4] The Problem of Varves, *Quart. Journ. Royal Meteorol. Soc.*, Vol. 54, 1928, pp. 64–70.

DR. DOUGLASS inquired as to how we could best get precise time relationship between the earliest-dated tree rings, say 3000 years ago, and the varves in northern Europe which extend back nearly to the last ice age. He pointed out that, whereas the chief tree control appears to be rainfall, in the varves temperature was almost the only factor and hence that a long period of overlapping years would be necessary to reach any kind of certainty in relationship.

DR. MERRIAM emphasized the importance of tracing relationship between trees and varves. The tree record will perhaps be extended in trees that lived in past time. He cited the case of the buried logs of the *Sequoia sempervirens* at Colma near San Francisco, which will give a ring record long before all living trees of that species.

Cycles in Peat Deposits

DR. A. P. DACHNOWSKI-STOKES, of the U. S. Bureau of Chemistry and Soils, considered certain basic facts in the analysis of peat deposit profiles for evidences of climatic changes and for a basis for coördinating results.

Peat materials can be subjected to analysis which permits identification of the botanical composition of the dominant communities of plants from which the layers have been derived. Facts accumulated by specialists in North America and Europe have demonstrated clearly that in both continents the composition and general characteristics of peat materials are similar and have been produced by similar response of vegetation to environment.

Stratification of peat deposits is also directly related to changes consequent on wet or dry conditions during the formation of the layers. Degree of decomposition is one of the chief criteria.

Evidence relating to changes in wet and dry or cool and warm periods has been obtained also from microscopic study of pollen in past profiles, researches on which have been carried out extensively in Europe. From the pollen curves it is possible to reconstruct the main features in the history of dominant forest types and arrive at a chronological system which can be used also for exact determinations of archeological and cultural relicts of man.

It may be stated that quantitative pollen analyses in this country, although still very inadequate, have shown rather strong local variations in the succession of forest communities and especially in the composition of deciduous forests. Conclusions as to climatic changes made on the basis of such analyses should therefore be deferred until sufficient material is at hand to permit more detailed fixing of boundaries of forests during different postglacial stages.

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[5] Mehrjährige Temperaturschwankungen vor 8 bis 18 Jahrtausenden. *Meteorol. Zeitschr.*, Vol. 45, 1928, pp. 263–265.

Table I—Sketch Outlining the Sequence of Climatic Changes Recorded in Peat Deposits

Climatic Periods after Blytt-Sernander		Succession of Vegetation and Peat Layers	Reactions
Present	Dry rising	Advance of heaths, shrubs, conifers, and hardwoods	Increasing decomposition of the organic surface layers with characteristics varying in degree and stage in different regional environments. Coastal dunes mobile
Sub-Atlantic	Moist	Development of younger layers of moss (Sphagnum), reed, and sedge peats. Secondary lake stages with sedimentary peat	Peat areas with predominantly anaerobic conditions and acid reactions; podsolization and degradation phases; coastal dunes fixed
Sub-Boreal	Dry-warm continental	"Grenzhorizont," woody peats from ericaceous heaths, deciduous and evergreen shrubs, and conifers	Moderate decomposition of the organic material and capillary uplift of soil solutions; black soil (chernozem-like) development
Atlantic	Moist maritime	Formation of older layers of moss (Sphagnum), reed, sedge and saw-grass peat. Lake stages with sedimentary materials and marls	Ground-water and lake levels high; stagnant water effects and formation of deoxidated compounds. Peat formation affected by atmospheric moisture
Boreal	Dry-warm	Older layers of woody peat from predominantly conifer-birch forests	Partial decomposition of fibrous peat layers and formation of absorptive complexes. Coastal dunes mobile
Pre-Boreal	Moist temperate	Extension of reed-sedge peats and of hypnum and saw-grass peat formations	Peat formations affected by prevailing saline character of ground waters
Sub-Arctic	Cool, windy continental	Predominantly accumulation of glacial lake marls and organic sediments	Formation of eolian inland deposits and loess
Arctic	Cold	Bare areas with transitional zones and belts of vegetation about the edge of the ice, slowly moving northward	Bare areas with ground-water levels high; soil solutions rich in mineral salts

Dr. Dachnowski-Stokes then took up the question of successional evidence, briefly referring to the way in which it had been built up by himself and others and presenting a summary of certain important points of comparison for a broader interpretation of profile records.

Study of correlation tables already published[6] and of Table I herewith shows that the striking sequence in stratification and profile features over large areas is explicable only by assuming that changes in climate and the related successions of peat layers were more or less continuous over practically the whole of North America and Europe.

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[6] A. P. Dachnowski: The Correlation of Time Units and Climatic Changes in Peat Deposits of the United States and Europe, *Proc. Natl. Acad. of Sci.*, Vol. 8, 1922, pp. 225–231.

The recognition that changes in vegetation are environmentally related leads to the assumption that the successional principles seen in existing vegetation hold equally well for the stratigraph sequence in peat deposits. As a consequence it is possible to organize peat profile records and to sketch very briefly the major climatic periods and their effects in tentative fashion.

Dr. David White commented on the inviting nature of the field for study of climatic changes existing in the plant-bearing Pleistocene deposits of the United States, especially the peat bogs and old soils. He stressed the importance of such complete observation of physical conditions that changes in flora might be definitely correlated either with changes of climate or with changes in the environment independent of climate.

Climatic Cycles and Changes of Vegetation

Dr. F. E. Clements, of the Division of Plant Biology of the Carnegie Institution, began his paper by observing that from the nature of its approach to problems of life in its environment, ecology deals constantly with cycles and with climatic cycles in particular. The initial interest of the ecologist in cycles is an outcome of the study of succession, itself a cycle. It was greatly stimulated by investigations in the working hypothesis that the sunspot cycle might be employed for anticipating changes in rainfall and hence in vegetation. Further investigation of work on these lines is now under way for stations west of the 90th meridian as well as those in the east with long-term records.

The water cycle is the fundamental cyclic process in which the action of rainfall and the reaction of vegetation assume preponderant rôles. The nature of the permanent or climax plant community determines in a great measure the kind of reaction and even more its intensity. Few exact measurements of the water loss from trees have been made, but recently the transpiration of grassland has been determined. The rôle of forest and grassland in reducing run-off and erosion has been settled beyond doubt by studies of Lowdermilk[7] on cultivated fields and temple forests in China, in which a ratio of 59:1 was found. More recently in the chaparral of southern California Lowdermilk and associates found a ratio as high as 100:1.

The complex of the relation of life to its environment is summed up in another cycle of processes. Out of it springs the development of the climax community known as succession, which constitutes the simplest and most visible cycle in vegetation. Wherever a climax is destroyed or new territory becomes available, succession follows until the climax is reëstablished. This is repeated as long as the climate endures; when a climatic shift occurs, a new climax ensues; thus each climax is an indicator of its particular climate. When a series of climatic changes occurs, as during an ice age, a corresponding cycle of climaxes, called a clisere, is constituted. All regions exhibit more or less topographic diversity and local climates to match. In these, fragments of original climaxes may persist as relicts for thousands of years and serve as keys to unlock the past in terms of climax migrations and the causative climatic shifts. Every great climax on the North American continent contains many such relicts. These fall into two major groups bearing definite relation to the climax in possession, especially as regards rainfall, the preclimax being drier, the postclimax wetter.

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[7] W. C. Lowdermilk: The Changing Evaporation-Precipitation Cycles of North China, *Proc. Engineering Soc. of China*, Vol. 25, 1925, pp. 97–128.

During the past decade the method of relict indicators has been applied to all climaxes of the continent north of the tropics and to the three great types of vegetation—forest, grassland, and desert. Death Valley and the Mohave Desert, for example, have yielded a series of communities from desert scrub to mixed prairie on the margin, corresponding to rainfalls of approximately 3, 6, 9, 12, 15 inches, representing climates and climaxes that succeeded each other in cyclic spiral of desiccation from the Miocene to the present. The existence of grassland under a rainfall of 15–20 inches is further attested by the presence of a late Miocene fossil fauna.

Cycles in animal populations are less directly related to climate, are fewer in number, and have been little studied. Elton has confirmed the existence of such cycles in operation at the present time, though they are relatively unimportant by comparison with great cyclic migrations of the Pleistocene.

The community bond in the climax, its developmental processes, and its basic dependence upon climate have supplied the guiding principles of paleoecology and contain the promise of a changed outlook upon paleoclimatology. Investigation of peat deposits and correlation with climatic cycles have been of first importance in this connection, since they place beyond question the uniformity of the relation between succession, climax, and climate from the present to the past.

Dr. David White remarked that it should surely be possible by careful planning and coördinated study to construct relatively complete records from the present year backward into Pleistocene time but that this would be only a beginning of the task of constructing a continuous record that would reach back into the Tertiary. In connection he spoke of the importance of the study of sedimentation from the standpoint of the deposition of seasonal or annual layers, a study new to most American geologists but now happily receiving more attention.

Mr. H. H. Clayton expressed the opinion that the climate of North America had been growing warmer and drier during the last century. Temperatures in the northern United States and Canada average from 1° to 3° higher than a half century ago. Desiccation is less easy to measure, but the downward trend of level of the Great Lakes during the last half century, while in part due to artificial causes, would seem to be also due in part to decreasing rainfall.

Dr. Clements believed there was some evidence to indicate that the present tendency is towards desiccation, though it is possible that this phase has reached its term. The distributing influence of man on vegetation and the possible telescoping relation of cycles make it difficult to answer the question of climatic trends with relation to a particular cycle.

In response to Dr. White, Dr. Clements asserted that, while the paleoecologist has a lively faith in the possibilities of the rings of fossil trees, varves, and other types of lamination, it appears quite impossible that these should ever yield a continuous chronology through the Tertiary to say nothing of the vast eras that precede it. On the other hand there is good reason to believe that the use of the climax as a universal indicator of climate will permit the reconstruction of past climates in clisere sequences that correspond to major or grand cycles.

General Discussion

Dr. Wieland, paleobotanist of Yale University, observed that in his judgment there was marked improvement in form in the present discussions of periodic phenomena as compared with those of the cycle conference of six years ago. The six years had tended to refine the methods of attack, to show the real need to go on scanning tree rings, flowering plants, rainfall, varves, cyclonic areas, sunspots, and all the phenomena sharing in or subject to the lesser and at last the great geologic course.

A point has been reached where some or all of the observations should be duplicated in the southern hemisphere. In case of tree rings and varves the Argentine-Chilean lake region affords an outstanding environmental unit for further study, comparing with our own Lake Chelan country. The pure stands of Araucarians about Lake Aluminé form one of the most imposing forests of the southern hemisphere. Only a few casual ring counts have been made; but, though not from the largest trees, these reached into the centuries. Probably no forest on the globe would afford finer comparisons of rings in one and the same type in varied situations and as affected by rain and snowfall and dryness than *Araucaria imbricata* taken as a whole on both dry and wet Andean slopes. Moreover, the region is intensely glaciated and varve data must be strikingly developed at many points.

Mr. E. N. Munns, in charge of the Forest Experiment Stations of the United States Forest Service, remarked that foresters are much interested in the study of climatic cycles both because of the influence of climatic changes on growth and reproduction of forests and their influence on protection. Droughty conditions are unfavorable to growth and reproduction and favorable to severe fires and insect enemies. He pointed out some dangers in correlating growth in tree rings with sunspots: the effect of human intervention in forest thinnings (which stimulate growth) and in causing forest fires (in America, however, there is a somewhat close correlation between fire scars of natural origin and sunspot cycles); lightning; the propensity of trees occasionally to drop a tree ring entirely, or of certain trees to make two rings in a single season.

Dr. Seth B. Nicholson, of the Mount Wilson Observatory, called the attention of the conference to the *Bulletin of Character Figures of Solar Phenomena*, the first number of which has just been issued by the International Astronomical Union. It contains for each day figures representing the activity of the sun as observed in spots or other solar phenomena, from which it is hoped to determine what are the best criteria at least in so far as their variations are related to terrestrial phenomena. He called attention to some characteristics of sunspot cycles, notably that the cycle is very definitely from minimum to minimum. The fact that the present cycle is less active than the last strengthens our belief in the reality of the 22-year period and lessens the weight of the long periods.

ANTARCTIC FLIGHTS OF 1928-1929

BY a few hours' flight on December 20, 1928, Captain Sir Hubert Wilkins has made some notable changes in the map of the Antarctic.[1] Graham Land, heretofore interpreted as a peninsula, he shows to consist of two major islands divided from each other by a winding ice-filled strait about the Antarctic Circle. The southern island is separated from the mainland by a broader ice-filled channel with a large and several small islands at its eastern end. Together with the character of the land on either side, this would seem to negative the conception that Andean folding extends across Antarctica. The insularity of Graham Land involves a point of historical interest. As a correspondent in the *London Times* points out,[2] "If Graham Land were actually a part of the Antarctic Continent, the honor of first sighting and charting any part of this territory would fall to an Englishman, Bransfield." This honor passes to Dumont d'Urville, who sighted Adélie Land in 1840, anticipating the American explorer, Wilkes, by a few days.

Here will be given the briefest outline of Wilkins' results with a map of the discoveries based on the radio despatches received. Wilkins will tell his own story in a subsequent number of the *Review*.

On November 6 Wilkins arrived at his base, Deception Island, north of Bransfield Strait, on the Norwegian whaler *Hektoria*, thus realizing his long ambition to return to the Antarctic. The excellent crater harbor of Deception Island, used by sealers since its discovery in the second decade of last century, is now the headquarters of the Norwegian southern whaling industry. The original plans of the expedition had called for the alternative establishment of a temporary base on the Weddell Sea, but unseasonable weather prevented this. "Summer conditions appeared three weeks earlier than usual." The ice in the harbor was melted before Wilkins could take off in his plane, and when a start became practicable wheels had to be substituted for skis and a limited load carried. On the day of the first flight Wilkins complains of the "excessive warmth," the temperature of the cabin being 64°. The discoveries from the air further exposed the necessity for a radical change in the original plans.

The morning of December 20 proved clear and calm; and Wilkins, with Eielson as pilot, took off on a course a little west of south, crossing Trinity Island and Palmer Land and following the eastern border of the land. Wilkins refers to the high tortuous plateau of North Graham Island—in places greatly narrowed, covered with crevassed glaciers, and cut by deep fiords. He observes certain differences in the southern island, "more irregular in surface, with many triangular-shaped mountains." A notable feature of the southern island is the four huge intensely crevassed glaciers that descend from the high rugged range of the interior. Southward the range peters out, though the island is reported as terminating in a bold promontory at the southeastern end. Low shelf ice constitutes the channel of Stefansson Strait uniting Weddell and Belgica seas; bordering it on the south side is a smooth snow slope that apparently rises uninterruptedly, probably to the polar plateau.

The southward flight lasted 5 hours and 25 minutes and was made for the most part at the rate of 120 miles an hour. On the return three cloud areas were seen to west and north, and speed was increased to 130 miles. Clouds filled Bransfield Strait; but, by keeping a compass course, the fliers arrived safely at their base after covering a total distance of 1200 miles.

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[1] American Geographical Society's Map of the Antarctic, 1 : 4,000,000, 1928.

[2] *London Times Weekly Edition*, Jan. 10, 1929, p. 36.

On January 10 another fine day gave opportunity for a second flight, 250 miles out along the same course. This permitted more attention to photography and a closer study of the terrain. A specific objective was the search for a more southerly base accessible by boat to be used another season.

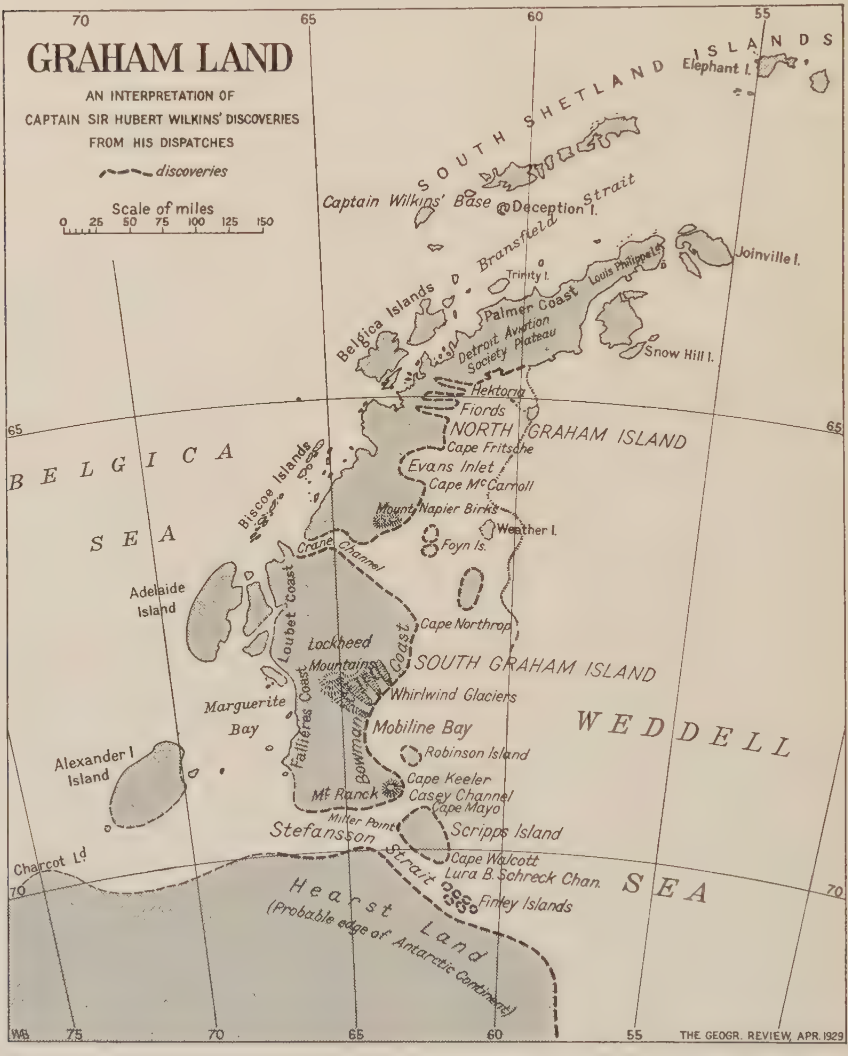

FIG. 1—Map of Graham Land, giving an approximate idea of Wilkins' discoveries based on his radio despatches. Scale 1 : 9,200,000. Compare Figure 2.

The flights showed the difficulties of landing: melting of the snow revealed "yawning chasms" in the land ice; the barrier ice of Weddell Sea near land also was badly crevassed where a smooth surface had been expected; where suitable landing places occur the use of skis would be necessary. Furthermore, had it been possible to land it would have been impossible to walk back the great distance along the coast of North Graham Island and impossible to cross its rugged summits. Unlike the Arctic, the food supply could not have been replenished on the shelf ice.

The flights make clearer than ever the part that aerial exploration must play in the Antarctic. We may quote the apt comparison of the *Times* correspondent: Wilkins "reached 'Evan's Inlet' (Nordenskjöld's 'Richthofen Valley,' latitude 66° S.) in less than two hours from his base at Deception Island. Nordenskjöld, advancing on foot from a base 50 miles nearer, took a fortnight to accomplish the same distance and could get no farther; while Wilkins, three hours later, was in latitude 71° S.—300 miles to the southward."

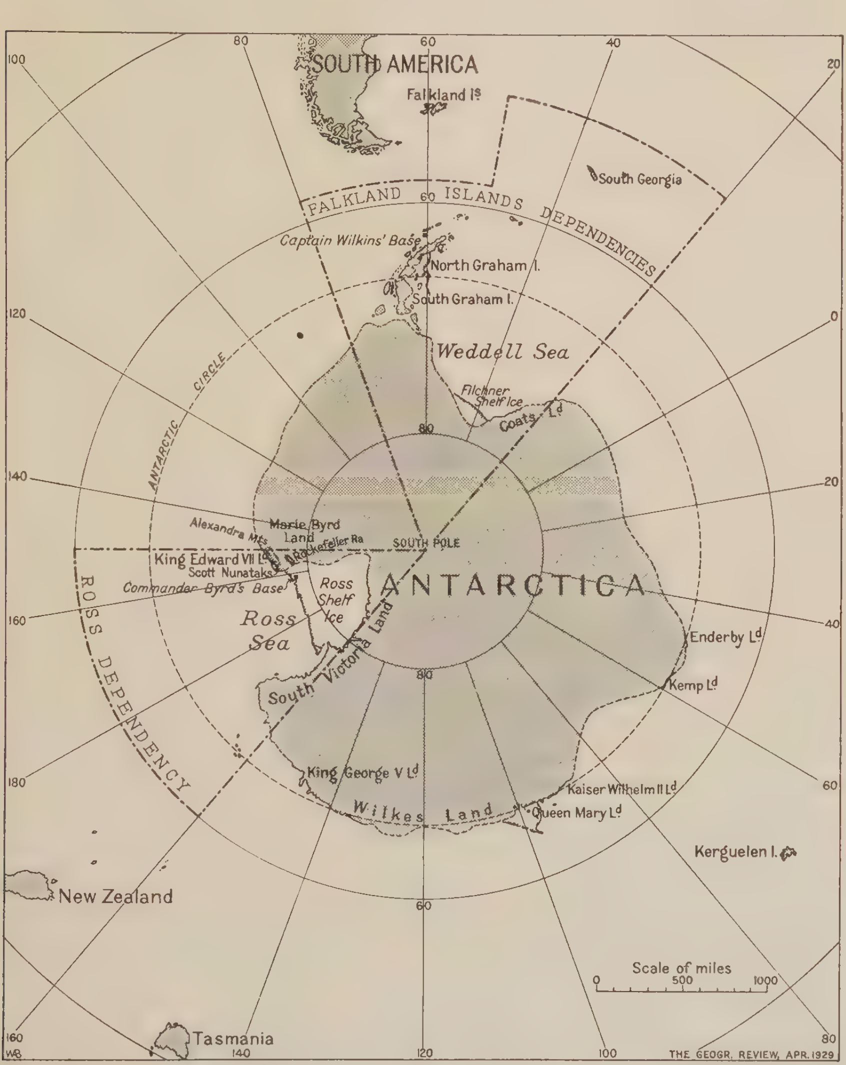

FIG. 2—Map of Antarctica showing the field of Byrd's explorations, the relation between the Ross Sea and Graham Land sectors, and the political status of these areas. Scale 1 : 75,000,000.

Meanwhile, on the other side of the Antarctic, Commander Richard E. Byrd had been establishing himself for a two years' stay, completing preparations for the winter and making preliminary flights. The Ross Sea Barrier was reached in longitude 177° 25′ West, 70 miles west of Discovery Inlet, on December 25. On the 28th the base was selected in the Bay of Whales, so named by Shackleton's expedition in 1908. Commander Byrd's base lies somewhat to the east of Framheim, Amundsen's base in 1911, and is reached through a small valley with a good passage up from the bay ice. It possesses the requisite of a good landing field. A short flight was made on January 16 to the west and south, a deep inlet in the Barrier being explored. Changes in the contour of the Barrier since Amundsen's time also are reported.

The first extensive exploratory flight was made on January 28. A course was taken northeast along the edge of the Barrier. About an hour out (flying at a rate of about 120 miles an hour) a large bight was observed and named Hal Flood Bay. Inland the Barrier surface began to get higher while coastwise a chaotic mass of crevasses extended for 20 miles. Scott Nunataks and the Alexandra Mountains, seen by Scott from the sea in 1902, came into view, the latter rising to some 1500 feet and showing bare rock on the northern slopes. The possibility of a channel or channels making King Edward VII Land an island is suggested but remains to be proved. A little over 50 miles from Scott Nunataks in a direction west by south a new range was discovered and named Rockefeller Range. It runs approximately northeast to southwest for some thirty miles. Fourteen peaks of not more than 2000 feet elevation were distinguished. Lieutenant Prestrud of Amundsen's expedition had ascended Scott Nunataks, but from the ground he failed to see Rockefeller Range.

On February 19 another flight was made in which two planes participated. Again the course was set northeast; but just before reaching Hal Flood Bay the planes ran into heavy clouds, and the course was turned southeast to about 15 miles south of the Rockefeller Range. Visibility here was perfect, at least 100 miles on either side. More mountains were sighted eastward. While the Rockefeller Range is within the Ross Sea Dependency administered by New Zealand, these mountains apparently lie without the territory, and the region has been claimed for the United States and named Marie Byrd Land. The course was then turned southward to a point 140 miles from the Bay of Whales.[8] Here another range, a "dark streak on the horizon" was seen, coinciding with the "appearance of land" reported by Amundsen in 81° 30′ South and believed by him to be a continuation of Carmen Land (86° to 84°). On the return many rolling hills of snow were observed and a few pressure ridges. The flight lasted 4 hours and 15 minutes, covered about 400 miles, and permitted the observation of some 40,000 square miles of new territory.

After the return Captain Ashley C. McKinley made another trip to the northeast and over the Rockefeller Range with the aero-camera, obtaining strip maps of the Range and of the uncharted stretch of coast line east of the Bay of Whales. From the Rockefeller Range he saw more clearly the mountains to the east: a peak, 8000 to 10,000 feet elevation, and "a long range to the east-southeast of it which disappeared over the horizon." Thus east, southeast, and south high land has been sighted; and, while the season for exploration in the Antarctic is now over, the omens are excellent for the coming year.

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[8] The Japanese South Polar Expedition (1911) made a sledge trip 150 miles southeast from the Bay of Whales, finding at this point an altitude variously stated at 1300 feet and 1000 feet. See "Problems of Polar Research," *Amer. Geogr. Soc. Special Publ. No. 7*, 1928, p. 320, and J. Gordon Hayes: Antarctica, 1928, pp. 306, 312. Also compare *Petermanns Mitt.*, Vol. 58, 1912, p. 34.

TWENTY-FIFTH ANNUAL MEETING OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS

THE Association of American Geographers met at New York on December 27, 28, and 29, 1928, for its twenty-fifth meeting. The 27th was devoted to an all-day field excursion. Papers were presented on the 28th and 29th in sessions held at the building of the American Geographical Society, with Professor Douglas Johnson of Columbia University, President of the Association for 1928, in the chair. On the two latter days members of the Association and others in attendance were guests of the Society at luncheon. The annual dinner was held at John Jay Hall, Columbia University, on the evening of December 28, Professor Albert Perry Brigham presiding.

The Anniversary Dinner

A special interest attaches to the annual dinner in that it marked the twenty-fifth anniversary of the Association. In his address as chairman of Section E, Geology and Geography, at the St. Louis meeting of the American Association for the Advancement of Science in 1903, Professor W. M. Davis spoke on the status of geography. Among the impediments to the due recognition of geography as a science he placed "the absence of a society of mature geographical experts." A year later this impediment was removed by the organization of the Association of American Geographers, started with a membership of "about fifty working geographers of North America" with Professor Davis as President.

The first speech of the evening was "Twenty-five Years of the Association of American Geographers: A Secretarial Review," in which Professor Charles C. Colby sketched the foundation and growth of the Association, with happy reference to personalities and papers of the earlier meetings. Professor Brigham, gave, in excellent form, "A Tribute to William Morris Davis, Founder of the Association." In delivering his tribute Professor Brigham said: "Hoping to speak to Professor Davis I find to my regret that I may only speak about him. Many years ago I wrote at some length of his career, but a score of years of achievement have passed since that time. 'One of the blessings of old age,' it has been said, 'is that money will buy most of the things it wants.' This is not true of our friend, to whom progress is the prime need. He has the eager mind and, in a high sense, wants the earth. 'He doth bestride the narrow world' may be said of him.

"He devoted himself to studies of the atmosphere, and then he gave himself to the lands, not merely their evolution but in good measure to a search of their regional parts. He was in South America when Mr. Hoover was an infant, in Europe he has studied in book and field and represented American geography there. Asia, Africa, and Australia have called him, and he might have said his 'nunc dimittis,' but no—with Horace he must 'grasp the ocean with his span.'

"Almost forty years ago I met him and from him gained this lesson, not in his words but in his spirit and example—*find it out for yourself and find it all out.* There was not then a working department of geography in any American University. Of what has grown since he might say, 'I saw, and a part of which I was.'

"I will not dwell on the chronology of his career, his part in the Committee of Ten, his pioneer texts, his St. Louis address, his founding of this Association upon expert standards, his strong precept and example for a quarter of a century. Enough is it for me to say that he is the leader and senior in geographical research in America and in the promotion of geographical study and interest.

"He has made geomorphology a science to a degree not otherwise attained in America or in any other country, a result due to keen observation, clear logic, and marked graphic skill. He has taught the teachers and led the investigators. For the proof, look around you tonight and go back in memory.

"He has encouraged and appreciated every phase of geography. He can write the so-called human geography when he pleases, as witness his 'United States' in Mill's International Geography. None more than he has welcomed to our circle men of all contributing sciences. I do not think he worries about the center or the circumference of geography, a science which will find its own and, if too aberrant, will be self-corrective.

"This Association grew out of physiography, or shall we say physiographers? Then we swung to human geography and perhaps became too free with the phrase 'geographic influence.' Now we are coming back to symmetrical views and modest caution. The face of the earth and the distribution and adjustment of life are all—geography. This is the most inappropriate time in all history to be concerned about the interfering or overlapping of any or all of the sciences. Despite our prejudices and programs geography in research and geography in education will take on what it wants and slough off what it does not want."

The presidential address followed. Considering that "the end of a quarter century is a fitting occasion upon which to take account of stock, survey the nature of the ground gained by us and our colleagues in other countries, analyze our present position, and estimate the direction in which we should seek to advance during the twenty-five years to come," Professor Johnson selected as his topic "The Geographic Prospect." His address, which will appear in full in the *Annals* of the Association, was avowedly in the nature of a jeremiad—presentation of the bright side of the picture had been left to others—designed to serve a salutary purpose. "The situation is one to give geographers ground for serious thought . . . dissatisfaction with the present status of geography is widespread in western Europe, as it is in this country." Professor Johnson confined his specific analysis to conditions obtaining in France, Great Britain, and Belgium. In conclusion he recognized the operation of six major and general factors. In the first instance is the youth of the subject, at least in its modern aspect. Arising out of youthfulness and imperfect standardization is the circumstance that geography draws to its field an unusually high proportion of inferior students. The vast scope and poor definition of the subject permit the play of centrifugal forces tending to disruption. The case between geomorphology and geography was instanced by Professor Johnson in advocating limitation and definition. Geography, furthermore, has been treated too largely as a synthetic and descriptive science: it must be elevated "by prosecuting researches in those aspects of the subject which demand the highest intellectual powers." This leads to the final criticism that geography is suffering from too much teaching and textbooks and from too little research.

THE EXCURSION

The holding of field trips was one of the objects of the Association gatherings in the plans laid down by Professor Davis at the first meeting (see *Bull. Amer. Geogr. Soc.*, Vol. 37, 1905, pp. 84–86). While there are obvious difficulties in the way, the experiences of the last three years—Philadelphia in 1926, Nashville in 1927, New York in 1928—seem to demonstrate that successful field trips can be arranged even in the winter season.

A program of sixteen introduced papers had been prepared in case the weather were too inclement; but conditions proved favorable, and the excursion, a study of the port of New York, was attended by some sixty professional geographers under the leadership of a committee composed of W. L. G. Joerg (chairman), John E. Orchard, and Lester E. Klimm (invited). As an introduction Mr. Klimm read a paper on the "Port of New York," which analyzed the preëminence of the port in national commerce and outlined the condition and problems presented by the harbor and the plans for its improvement. A mimeographed abstract of the paper illustrated with maps and diagrams was distributed to the members. The party then embarked on the *Macom*, which had been placed at the disposition of the Association by the Mayor's Committee for the Reception of Distinguished Guests.

The trip down the Hudson from 79th Street displayed the concentration of docks and railroad terminals fringing the Manhattan and New Jersey shores of the Hudson River, and the Upper Bay teeming with water-borne traffic. In South Brooklyn visits were paid to the large grain elevator at Gowanus Bay, where grain is received via the New York State Barge Canal, and to the Bush Terminal, where a single corporation leases coördinated water, rail, storage, and manufacturing facilities. Passing through Kill van Kull and up Newark Bay, where steel mills and oil refineries are congregated, Port Newark was reached. Here a unified terminal with, among other features, large lumber yards and an aviation field, is being developed on land reclaimed from the salt marshes.

The Papers: Economic and Regional Studies

Thirty-two papers by members were announced: twenty-nine were presented and an additional introduced paper. Economic papers lent a distinct *cachet* to the program. Helen M. Strong opened with "Geography in Business," in which she described the services afforded by the U. S. Department of Commerce to the business men of the country and the increasing extent to which they avail themselves of it. A current problem of wide interest was treated by W. H. Haas in "The Mississippi Problem: A Conflict in Economic Emphasis"; while Frank E. Williams dealt with a rather unusual point of detail in "Some Effects of Culm in the Schuylkill River," where, it may be noted, the recovery of anthracite from the river deposits is a matter not without practical interest. Other economic papers in the home field were Lewis F. Thomas' "Geographic Aspects of Recent Plant Locations in Metropolitan St. Louis" and Richard Hartshorne's "Manufactural Geography of the Central Northwest of the United States," the former following up work presented at the 1926 meeting, the latter forming part of a comprehensive scheme under way at the University of Minnesota for study of the region. In the foreign field John E. Orchard discussed the problem "Can Japan Develop Industrially?" in a paper published in this number of the *Geographical Review*. Glenn T. Trewartha, whose monograph "A Geographic Study in Shizuoka Prefecture, Japan" was recently published in the *Annals of the Association of American Geographers*, presented another of his field studies, "The Suwa Basin: A Geographic Study in the Japanese Alps," made in the Far East in 1926–1927. R. H. Whitbeck spoke on "The Chileans and Their Geographic Environment."

Regional survey methods, which have for some time engaged the attention of several members of the Association, found expression in two papers by V. C. Finch: "The Service Area of Montfort: A Study of Landscape Types in Southwestern Wisconsin" and "The Geographer's Field Map as a Permanent Record of Landscape Forms," the latter read by title. Special mention should be made of the finely executed map series of the Montfort area showing relations between conditions of slope, soil, drainage, and roads and land utilization. Roderick Peattie (introduced) entered into the question of method in the mapping of land utilization with an illustration from Conflent in the French Pyrenees. Robert S. Platt contributed a "Field Study of a Sugar District: Mariel, Cuba." Also dependent on the author's field work in our arid southwest was Kirk Bryan's "Flood Water Farming." J. K. Wright described the first steps taken in the American Geographical Society's program of population studies in New England.

PHYSICAL GEOGRAPHY

Three papers dealt with regional climatology. C. F. Brooks described and interpreted "The Rainfall of New England" and, in the absence of R. M. Harper, presented for him the illustrations of "A Regional Study of the Climate of Georgia." These included a regional map (with some modifications similar to that appearing in the *Geogr. Rev.*, Vol. 10, 1920, p. 342) and regional graphs of average monthly precipitation and mean daily temperature. The rainfall graph exhibited striking differences in the seasonal distribution by regions. In "The Monsoon Rain, an Economic Terror to Mankind" J. Russell Smith sought an explanation of the recurrent famines to which India is subject and compared conditions there with conditions in the mid-western states of America.

"The Third Estate in Geography," by Alexander McAdie, had reference to aerography, in particular to the conception of atmospheric stratification. In the domain of geomorphology was Wallace W. Atwood's "Some Open Problems in the Physiography of North America." O. D. von Engeln discussed "Forms of Waterfalls and Gorges," illustrating the variety of types with examples from central New York State. R. H. Sargent, in "Notes on Certain Geographical Features in Alaska," described some of the more striking discoveries made by the U. S. Geological Survey in the Mt. Spurr region and the Alaska Peninsula.

In "A New Projection for the World Map: The Polar Equal Area," J. Paul Goode presented a new arrangement of Werner's projection suitable for showing the land masses in relation to the North Pole. He pointed out certain family traits common to the sinusoidal, Bonne, and Werner projections in addition to equal area—the central meridian a straight line with correctly spaced parallels and parallels divided truly. Raye R. Platt described and illustrated the progress made on the American Geographical Society's Millionth Map of Hispanic America since its inception seven years ago.

OTHER PAPERS

There were two papers in historical geography: Miss Semple in pursuance of her classical studies dealt with "Irrigation and Land Reclamation in Ancient Mediterranean Lands." N. A. Bengtson spoke on "Significant Geographic Aspects of the Exploratory Period in the History of Central America," concluding with the observation that the boundary disputes between Guatemala, Nicaragua, and Honduras that arose in the earlier part of the sixteenth century were still vexed questions today.

In the field of methodology D. S. Whittlesey presented "A Schema for Studying Agricultural Occupance of Land," closely related to the land utilization studies to which reference has been made. Wellington D. Jones, in "Ratios in Regional Interpretation," made a plea for mapping of relationships among a great variety of data, illustrating with examples from India, Australia, and the United States. George D. Hubbard spoke on "Geographic Conditions, Influences, Controls." W. L. G. Joerg read an obituary on Cyrus C. Adams, who died on May 4, 1928. Mr. Adams, for many years on the staff of the American Geographical Society, latterly as editor of its *Bulletin*, had been a member of the Association of American Geographers since its foundation, being elected to its council at the organization meeting in 1904 and serving as president in 1906.

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of December, January, and February. The regular monthly meeting of the American Geographical Society was held on December 18, 1928, at the Engineering Societies' Building, 29 West 39th Street, President Finley in the chair. Commander George Dyott addressed the Society on "The Search for Colonel Fawcett." He gave a fully illustrated account of his experiences in the prosecution of this search from the upper Paraguay to the headwaters of the Xingu and down that stream to the Amazon. He presented his conclusions that Colonel Fawcett, whose last message to civilization was sent out in 1925, had been murdered by Anafuqua Indians in the upper drainage basin of the Xingu.

The Annual Meeting of the Society was held on January 22, 1929, at the Engineering Societies' Building, 29 West 39th Street, President Finley presiding. The Annual Report (printed below) was read and the officers for 1929 elected. As a prelude to the addresses of the evening President Finley made some interesting comments on an expedition of his own: an airplane flight from the Atlantic to the Pacific coast during the past summer. He spoke of the striking features of the landscape from the great stretches of forest in the mountains of Pennsylvania to the majestic peaks, Shasta and Tacoma, of the Pacific coast and concluded with a eulogy of his pilots "a new race of young heroes. . . . They are the new American geographers, and we are at the beginning of a new era of geography, the era of aerial geographical observation." Accounts of two recent expeditions under the auspices of the Society followed. Mr. Joseph H. Sinclair spoke of his expedition to Eastern Ecuador (see pp. 201–217 of this *Review*). Mr. O. M. Miller described "The 1927–1928 Peruvian Expedition of the American Geographical Society" (see *Geogr. Rev.*, Vol. 19, 1929, pp. 1–37). Both addresses were illustrated with motion pictures.

At the regular monthly meeting of the Society on February 26, 1929, held at the Engineering Societies' Building, 29 West 39th Street, President Finley presiding, Mr. Owen Lattimore addressed the Society on "The Desert Road to Turkestan." In his journey from China to India across southern Mongolia and Chinese Turkestan in 1926–1927 Mr. Lattimore followed for 1600 miles a route previously unknown. His address was illustrated with still pictures.

Elections to Fellowship. At the December, January, and February meetings of the Society, President Finley presiding, there were presented with the approval of the Council the names of 352 candidates who were duly elected as Fellows of the Society.

Recent Publications

The Manners and Customs of the Rwala Bedouins. This volume, by Professor Alois Musil, is No. 6 of the Society's series *Oriental Explorations and Studies*. The Rwala are the greatest and most powerful tribe of the north Arabian deserts. Camping and migrating with them during many seasons, Musil was able to observe their daily life in its details and to learn much of their folklore and *mores*. The present work gives a full and systematic description of nearly every phase of the activity and thought of these people. Nearly 200 Bedouin poems are translated, transcribed, and explained. The appearance of the volume completes the publication by the Society of the scientific results of Professor Musil's explorations of 1908–1915 (see *Geogr. Rev.*, Vol. 15, p. 297; Vol. 17, pp. 145, 178, Vol. 18, pp. 144, 497, Vol. 19, p. 149).

ANNUAL REPORT OF THE COUNCIL

New York, January 22, 1929

To the Fellows of the Society:

The primary object of the Society is research—to extend the boundaries of geographical science through intensive field work as well as exploratory expeditions and the better organization of reference material. Parallel with this purpose runs the plan of distributing the results of its work as effectively as possible. This is done through a journal devoted mainly to original material, a series of scholarly monographs, maps based in most cases upon original field data, and bibliographies and catalogues designed to elevate the standards of scholarship. It is in the light of this policy that the following report is presented.

THE GEOGRAPHICAL REVIEW

The *Geographical Review* counts as one of the most distinguished contributions to the volume for 1928 Captain Sir Hubert Wilkins' report on "The Flight from Alaska to Spitsbergen, 1928, and the Preliminary Flights of 1926 and 1927," with Sir Napier Shaw's comments, "Arctic Weather of April 15–16, 1928, With Some Observations on Polar Weather in Relation to the General Circulation," illustrating the far-reaching importance of first-hand knowledge of polar meteorology. The results of another Arctic expedition, endorsed by the American Geographical Society, are told by Mr. G. P. Putnam in "The Putnam Baffin Island Expedition," which made important rectifications in the map of Baffin Island and took lines of soundings in the Foxe Basin to its northern end at Fury and Hecla Strait.

The first soils map of Cuba to be published accompanies Mr. H. H. Bennett's "Some Geographic Aspects of Cuban Soils" and is a good example of pioneer work in soil geography. Equally noteworthy is Mr. Bennett's contribution "The Geographical Relation of Soil Erosion to Land Productivity," with striking photographs and quantitative maps giving graphic expression to this serious national problem. Progress in the field of oceanography is illustrated by Dr. Henry B. Bigelow's "Exploration in the Waters of the Gulf of Maine" with a series of maps showing physical and biological elements. Mr. H. A. Marmer's broad history of the development of "Cotidal Maps" should also be mentioned. Dr. J Harlen Bretz interprets the unique physiography of "The Channeled Scabland of Eastern Washington" with the aid of a map in color on the scale 1:500,000. Another map in color shows "The Gathering of Floods in the Connecticut River System" during the disaster of November, 1927, with an analysis of the problem by Professor J. W. Goldthwait.

One of the most notable features of Volume 18 of the *Geographical Review* is the number of papers dealing with population. The general problem is envisaged by Dr. O. E. Baker in "Population, Food Supply, and American Agriculture." A specific illustration of the problem in acute form is Dr. J. E. Orchard's "The Pressure of Population in Japan." Stages in the occupation of a pioneer region are traced by Dr. Guy-Harold Smith in a series of well-conceived dot maps of "The Populating of Wisconsin." He has, similarly, "A Population Map of Ohio for 1920." Attention may also be called to the expressive dot map of distribution of population in Iceland accompanying Mr. Earl Hanson's "The Renaissance of Iceland." Another type of the population-density map is by Dr. F. Dixey and shows "The Distribution of Population in Nyasaland." The distinguished Russian geographer Professor Benjamin Semenov-Tian-Shansky contributes "Russia: Territory and Population, A Perspective on the 1926 Census," with a series of six maps giving quantitative and qualitative expression to population distribution and furnishing a geographical background. Some early population problems are treated by Dr. H. J. Spinden in "The Population of Ancient America"; while the historical process of human occupation of the earth is analyzed by Dr. H. W. Ahlmann in "The Geographical Study of Settlements: Examples from Italy, Germany, Denmark, and Norway." Closely related to the population problem is Dr. H. Foster Bain's suggestive paper "The Third Kingdom: Some Reflections on Our Mineral Heritage."

Altogether there were published in the *Geographical Review* for 1928 35 leading articles, 65 items of geographical record, and 74 reviews. In addition to the many text maps and diagrams there were seven insert maps.

Through the generosity of Robert Lee Forrest, a Fellow of the Society, the *Geographical Review* is now distributed to a large number of foreign scholars to whom it had not been available hitherto. The special thanks of the Council were conveyed to Mr. Forrest for his far-sighted action, which we hope will be extended in range by contributions of other Fellows who are especially interested in the wider distribution of the *Review*.

Books and Maps

The books and maps published by the Society during the past year include the following:

1. Problems of Polar Research, by thirty-one authors.

A coöperative volume written by thirty-one of the leading authorities on polar problems. It informs the layman of the underlying purposes of polar exploration and assists the scientist by making available to him the plans and ideas of experts for the benefit of future exploration.

2. The Geography of the Polar Regions, by Otto Nordenskjöld and Ludwig Mecking.

A companion book to Problems of Polar Research. It constitutes the most complete regional reference book in English in polar geography.

These two books on polar research were produced in an effort to center attention upon the major problems remaining to be solved by further field study, to discover where and by what means they may best be attacked, and to suggest the form of coöperation between the sciences most concerned that would yield the best scientific results.

3. The Coral Reef Problem, by William Morris Davis.

This volume contains the author's original field studies for a period of ten years together with a review of the work of other scientists during the past century. It is a worthy successor to Darwin's classic study of coral reefs and demonstrates the essential soundness of Darwin's conclusions.

4. The Last Glaciation, with Special Reference to the Ice Retreat in Northwestern North America, by Ernst Antevs.

A world survey of Pleistocene glaciation with a detailed study of the clay layers in the Hudson and Connecticut valleys and Canada in continuation of The Recession of the Last Ice Sheet in New England, by the same author, published by the Society in 1922.

5. Richard Hakluyt and the English Voyages, by George B. Parks.

This book is the first comprehensive life of Hakluyt, editor of the "English Voyages" and geographer of the period of most active English expansion. There is a brilliant introduction by the leading English authority on England's colonial expansion, Dr. J. A. Williamson.

6. Bibliographie Géographique.

In coöperation with the Association de Géographes Français the Society has continued its work on the Bibliographie Géographique. To the number for 1927 the staff of the Society contributed about 400 bibliographical references and 150 brief reviews.

7. THE MIDDLE EUPHRATES, PALMYRENA, AND NORTHERN NEĞD, by Alois Musil.

In the reports for 1926 and 1927 attention was called to the publication of the first two of a series of six volumes on Arabian geography, history, and folklore by Professor Alois Musil of the Charles University, Prague. During 1928 three volumes, THE MIDDLE EUPHRATES, PALMYRENA, AND NORTHERN NEĞD, were published; and at the close of the year the final volume, THE MANNERS AND CUSTOMS OF THE RWALA BEDOUINS, was in the hands of the binder.

8. MEDALS AND MEDALISTS.

Under this title there has been published a booklet describing the four medals awarded by the Society for distinguished work in exploration and geographical science. It contains a list of the recipients, a group of selected presentation addresses by officers of the Society and by diplomatic representatives who have acted on the Society's behalf, and photographic illustrations of each medal.

9. THE LEARDO MAP OF THE WORLD, 1452.

The Society has for some months had an engraver working on a full-size reproduction in color of the world map of Giovanni Leardo (1452 or 1453), the original of which was presented to the Society in 1906. This facsimile has been printed, and the edition is in process of distribution. The map is accompanied by an illustrated descriptive book of 89 pages.

10. MAP OF THE ANTARCTIC AND NAVIGATIONAL CHART OF THE ANTARCTIC.

The Society has reproduced a large-scale base map of the Antarctic from the same drawings that served for the printing of the field sheets supplied to the Antarctic expeditions of Commander Richard E. Byrd and Captain Sir Hubert Wilkins. The map was compiled from over seventy-five original sources. Accompanying the large map is a *Navigational Chart* on a small scale, suitable for constant reference by both navigator and pilot in airplane reconnaissance.

11. In the *Geographical Review* the following insert maps have been published: a map of Foxe Land, Baffin Island, to Show Route Surveys by the Putnam Baffin Island Expedition, 1927; map of Principal Soil and Topographic Regions of Cuba; Population Maps of Wisconsin 1850, 1860, 1870, 1880, 1900, 1920; Population Map of Ohio, 1920; a series of maps showing Floods of the Connecticut River System in New Hampshire and Vermont, November, 1927, at different stages of progress; map of Channeled Scabland and Associated Features on the Columbia Plateau in Washington; Central America Rainfall Map.

12. MILLIONTH MAP OF HISPANIC AMERICA.

The work of the Society has now been completed on thirty-seven sheets of the Millionth Map of Hispanic America. Sixteen of these sheets have been published; full-color proof has been received for eight others and printing on these is proceeding as rapidly as possible. The firm which is doing the lithography and printing of the map has now recovered from the effects of the lithographers' strike which, as announced last year, seriously delayed the printing of the sheets; and it is expected that the reproduction of the remaining thirteen sheets now in the lithographers' hands will proceed without delay. Fairdrawing is in progress on four additional sheets, and compilation has been completed on six others.

Much new source material has been assembled during the past year, particularly for the Colombia and Venezuela sheets; while the surveys of Mr. Joseph H. Sinclair carried out in 1927–1928 in the Oriente region of Ecuador under the auspices of the Society and the surveys made by the Society's 1927–1928 expedition to Central Peru have contributed much valuable material in these two little-known areas. The interest of the Hispanic American governments in the map has continued during the past year, and several of them have contributed copies of important new surveys.

FIELD EXPEDITIONS

By a carefully planned flight of 20½ hours' duration over a course 2200 miles long, Captain Sir Hubert Wilkins was able to bring to a brilliant conclusion three seasons' work in the Arctic under the auspices of the Society and with the aid of the Detroit Aviation Society and the *Detroit News.* In the report of the Chairman for 1927 note was made of the flight of that year to a point 550 miles northwest of Point Barrow and of the valuable sounding taken after a successful landing on the ice. The flight of 1928 was designed to explore the great area between the track of the *Norge* and the Canadian Arctic Archipelago. It traversed the region where "Crocker Land" was supposed to exist and also crossed certain unexplored tracts between Greenland and Spitsbergen. Captain Wilkins published his scientific report in the *Geographical Review* for October and turned over to the Society all of his original records. Copies of these were supplied to both the Royal Geographical Society of London and to the Scott Polar Research Institute at the University of Cambridge.

Upon his return, Captain Wilkins immediately planned his long-delayed expedition to the Antarctic under the auspices of the Society and with the support of the Hearst newspapers. From a base at Deception Island where he was landed with all of his equipment and personnel by the Norwegian whaler *Hektoria*, he was able in a nine-hour flight on December 15, 1928, to explore Graham Land, demonstrate its insular character, and photograph its eastern coast. On January 10, 1929, he completed a second flight in search of a base, but, finding none, announced his plan to return and from a new base next year make the projected flight across the American and Pacific quadrants of Antarctica to the Ross Sea. Especial mention should be made of the services of Ben Eielson, who in both the Arctic and the Antarctic flights was associated with Wilkins as pilot and who deserves the highest praise for his extraordinarily skillful and courageous part in the work.

In the Ross Sea area of Antarctica, Commander Richard E. Byrd is conducting an exploration by airplane that promises to bring back results of the greatest value to science. The Society endorsed his expedition and, at his request, assisted him in his plans by defining the objects of study (see also PROBLEMS OF POLAR RESEARCH and THE GEOGRAPHY OF THE POLAR REGIONS). The geologist-geographer was chosen on the recommendation of the Society. We were able to supply the specially constructed base maps and navigational charts of the expedition and to lend a number of instruments. Commander Byrd has the support of many individuals and institutions, and his work is being followed closely by the American people. With the excellent administration that the expedition will receive the scientific results will be awaited with the greatest interest.

THE SCHOOL OF SURVEYING

In addition to ten students in the School of Surveying, most of whom are already in the field or who expect to do field work during the coming year, there have been numerous inquiries, both personal and by correspondence, for information on surveying and astronomical subjects. At the end of 1927 about 35 star lists for the equal-altitude method for the determination of latitude and longitude had been compiled. Each list covers one degree of latitude. This year an additional 40 were finished. Among others the lists have been used by the Canadian Topographical Survey, the Inspector of Surveys, Sudan Government, and the Aircraft Operating Company working in Northern Rhodesia.

One of the new Shortt Synchronome clocks is being installed at the School. When this type of clock is put in proper adjustment it is possible to predict its error in absolute time within one-tenth of a second several months in advance. Further investigations were made of suitable radio sets for receiving time signals in the field. As time signals are now being transmitted on very short wave lengths, a short wave set has been made weighing about twenty pounds, suitable for use in the field and similar in practical details to the long wave sets already made.

Mention may be made of the mathematical work done by the School on the navigational and plotting charts prepared by the Society for the Byrd and Wilkins expeditions and in the analysis of the navigational data of the Wilkins' flight from Barrow to Spitsbergen.

Studies of Pioneer Lands

By reference to the Annual Report for 1927 (*Geogr. Rev.*, April, 1928) it will be noted that the first step in the project for the study of the settlement of undeveloped lands was the publication of a book by twenty-five or thirty authors setting forth the present problems that confront pioneer settlers in regions of active development. A committee of Canadian scholars met at Ottawa May 11 and 12 with members of a committee formed in the United States and worked out the details of a program of study adapted to Canadian conditions. This was followed by the reference of the project to the Society for administration on the part of the Social Science Research Council. The program for field work in Canada for 1929 has been approved, and funds have been appropriated for carrying it out.

Through correspondence and conference an impetus has been given to the study of pioneer conditions in the principal pioneer belts of the world as these have been outlined in a preliminary paper entitled "The Pioneer Fringe" (*Foreign Affairs*, October, 1927). From the information already collected it is clear that the impetus so given will result in independent field studies of great value to science and to humanity. It is expected that this work will progress much faster when the principal problems are systematically presented, with abundant field illustrations, in the book on Pioneer Belts now under way.

New England Studies

Material progress has been made in the specialized studies of the New England region as announced in the report for 1927. During the summer field studies were carried out on the recreational population of certain critical areas in New Hampshire. A visit was made to New England state capitals, historical societies, and libraries to establish contacts with state officials and others and to obtain documentary materials in the form of maps, statistics, and reports. A survey of the documentary sources of particular value in regard to the human geography of New England has been initiated, and experiments are being made to determine the cartographic methods best adapted to give expression to the statistical and other data which this survey is bringing to light. Further work along these lines will be conducted by members of the staff of the Society; and specialists qualified to discuss problems of New England's agriculture, manufactures, and social life will be invited to take part in the further development of the program.

Representation at Scientific Meetings

The Society sent a representative (who represented the National Research Council on appointment of the National Academy of Sciences) to the Twelfth International Geographical Congress which met at London and Cambridge, July 14–26. A report of the Congress was published in the *Geographical Review* for October, 1928. The same representative, appointed by the Department of State as one of two official delegates of the United States government to the International Millionth Map Commission, attended the sessions of the Commission held in London on July 12.

The Society appointed J. A. Morrison of the University of Chicago as its representative at the centenary of the Gesellschaft für Erdkunde zu Berlin in May, 1928, and a report of the proceedings of the meeting prepared by Mr. Morrison was published in the October number of the *Geographical Review*. This was one of the most important scientific meetings of the year and resulted in a collection of papers of unusually high quality.

The Association of American Geographers

It was the privilege of the Society to welcome to its house on December 28 and 29 the Association of American Geographers on the occasion of the Twenty-fifth Anniversary meeting and thus to continue happily the relations so long maintained with this important organization. A full account of the meeting will be found elsewhere in this number of the *Geographical Review*. Through the kindness of Mr. Grover A. Whalen, Chairman of the Mayor's Committee for the Reception of Distinguished Guests and now Police Commissioner of New York, it was possible for the Society to secure the use of the city tug *Macom* for an all-day inspection of New York Harbor on December 27 as part of the program of the Association.

Library

In the report for 1926 it was explained that particular emphasis was being placed upon organizing the collections of the Society specifically for geographical research. This work was continued in 1928, cards representing over 5750 books, pamphlets, periodicals, and maps being entered in the special research catalogue. Members of the library staff also coöperated in the preparation and editing of abstracts of publications in human geography for the new monthly journal *Social Science Abstracts*, and in the preparation of analysis for the annual volume of *Bibliographie Géographique*.

Additions to the library during the year comprise 1016 books, 596 pamphlets, 9416 new issues of periodicals, 2849 maps, and 73 atlases. The total number of volumes in the library at the close of the year was 90,350; pamphlets, 11,890; maps, 71,741; atlases, 1465. Over 9000 cards were added to the book and pamphlet catalogue and 4683 to the map catalogue.

Gifts and Notable Accessions

Among conspicuous gifts to the collections from friends of the Society have been the following: The notebooks and original maps kept by Captain Wilkins preparatory to and during his flight across the Polar Basin in the spring of 1928; a collection of 234 books from the library of the late James B. Ford, presented by his cousin, Dr. Louis F. Bishop; a set of 50 photographs of Caribbean scenes by Henry J. Thayer of Boston.

Other important additions, through purchase or exchange, are: A set of the Jahresberichte des Geschichtewissenschaft, Vols. 1-36; 80 publications from the geological committee in Leningrad dealing with geological exploration in the gold-bearing districts of Siberia; Crown Collection of photographs of American Maps, Series IV; U. S. Catalogue of books in print 1928; Dictionary of American Biography, Vol. 1; Union List of Serials; sets of topographic sheets for Siam (278), Morocco (145), Spanish Morocco (48), Gold Coast (122), and Sierra Leone (14).

Lecture Program

The speakers and titles upon the Society's lecture program during the past year are as follows:

Dr. Matthew Stirling, "An Airplane Expedition to the Pygmies of New Guinea"; Professor Alois Musil, "Desert Life in Northern Arabia"; Dr. Francis W. Pennell, "The Andes of Colombia"; Mr. Charles R. Crane, "Moslem Culture in the Yemen and the Hejaz"; Dr. Fridtjof Nansen, "Problems of Arctic Exploration"; Mr. Herbert E. Bradley, "An Unknown Cannibal Country in the Belgian Congo"; Commander George Dyott, "The Search for Colonel Fawcett."

Medal Award

The Samuel Finley Breese Morse Medal of the Society was awarded, for the first time, to Captain Sir Hubert Wilkins in recognition of his Arctic explorations during the field seasons of 1926, 1927, and 1928, culminating in his flight from Barrow, Alaska, to Spitsbergen on April 15, 1928.

Fellows

The number of Fellows at the close of the year was 5427, of whom 401 are Life Fellows. In addition there are 4 Honorary Members and 33 Corresponding Members.

James Bishop Ford

During the year the Society suffered the loss of James B. Ford, one of its oldest friends, long a Councilor and in recent years a Vice-President. During the period of his association with the Society Mr. Ford not only gave liberally to its support but also followed its work with the closest personal interest. He was especially helpful in the work upon the Millionth Map of Hispanic America, though he also assisted liberally in the growth of the library and in the maintenance of the publication fund which made the special monographs and research series possible. Beginning in 1918, he contributed to an increasing degree to field expeditions, especially those to South America and the Arctic in which the Society had a part. He was a singularly wise counselor and loyal friend.

The report of the Treasurer submitted herewith gives a summary of the income and expenses of the Society. The accounts of the Society have been audited by professional accountants. They are presented as heretofore in condensed form below.

Philip W. Henry
Chairman

REPORT OF THE TREASURER FOR 1928

Receipts and Expenses

During the year there have been received from annual dues, interest on investments, and sales of publications	$79,336.67
There have been expended for salaries, house expenses, library, meetings, publications, postage, insurance, etc.	94,109.90
Balance charged against Special Deposit Fund	$14,773.23

Condensed Balance Sheet, December 31, 1928

Cash	$ 11,697.82
Sundry balances and investments	252,465.45
Inventory of publications	13,209.25
	$277,372.52
Capital Account, Balance uninvested	5,831.48
Annual dues paid in advance	5,703.41
Special Fund for general purposes	18,377.71
Sundry deposits and reserves	17,046.29
Millionth Map Publication Fund, Balance	230,413.63
	$277,372.52

REPORT OF THE SPECIAL COMMITTEE

New York, January 17, 1929

The committee appointed at the meeting of the Council held on December 13, 1928, to nominate officers for the vacancies to occur in the Council in January, 1929, beg to nominate the following named gentlemen for the offices designated and move that the same be approved and presented to the Society for election at its meeting to be held on January 22, 1929.

		Term to expire in
President	John H. Finley	January, 1930
Vice-President	Philip W. Henry	January, 1932
Domestic Cor. Secretary	Paul Tuckerman	January, 1932
Treasurer	Henry Parish	January, 1930
Councilors	Madison Grant John Greenough Roland L. Redmond Franklin D. Roosevelt	January, 1932

H. Stuart Hotchkiss
Hamilton Fish Kean } *Committee*
Philip A. Carroll

GEOGRAPHICAL RECORD

NORTH AMERICA

Research in Agriculture and Land Utilization in New England. No better evidence of the geographical unity of New England is needed than the formation in recent years of two coöperative organizations designed each in its own way to serve the combined interests of all six of the New England states. One of these, the New England Council, was founded in 1925 and is made up of twelve representatives from each state together with associate members, who may be individuals, firms, or associations. Through committees on agriculture, power resources, community development, research, recreational resources, public relations, and external relations the New England Council is conducting an active campaign to promote "the growth and prosperity of the New England States."

The other organization, the New England Research Council on Marketing and Food Supply, is somewhat older than the New England Council and, as its name implies, is strictly a research body. Its purpose is "to stimulate and coördinate the studies of economic problems connected with the supply of foods and other agricultural products of New England." Its membership consists "of the representatives of institutions and agencies actively engaged in prosecuting such economic studies," including "the U. S. Department of Agriculture, the State Departments of Agriculture, colleges, universities, and other public or semi-public institutions." At the annual meetings brief reports are presented on the progress of agricultural research throughout New England, more extended papers are read and discussed, and recommendations are adopted. In December, 1928, Mr. F. V. Waugh, Executive Secretary of the Council, distributed to its members a valuable multigraphed pamphlet entitled "Tentative Bibliography of Published and Unpublished Research in Agricultural Economics, Farm Management, and Rural Sociology in the New England States," in which are given not only the titles of publications and unpublished studies but brief analyses of their contents.

At the annual meeting held in Boston on December 6 and 7, 1928, as an innovation a day was devoted to a special conference on land utilization. The broad question of the purpose and methods of studies in land utilization was discussed from different points of view by Dr. John D. Black of Harvard, Professor I. G. Davis of the Connecticut Agricultural College, and Dr. Alexander E. Cance of the Massachusetts Agricultural College. Opportunities for coöperation among institutions and individuals in carrying out comprehensive studies in this field were suggested by Dr. L. C. Gray of the U. S. Department of Agriculture. "Research in Forestry in New England that Relates to Agricultural Land Utilization" and "Prospects for the Utilization of Land for Timber in New England" are the titles of addresses delivered by Professors H. H. Chapman of the Yale Forestry School and R. T. Fisher of Harvard respectively. Other papers dealt with matters of more limited scope: studies of land utilization in Vermont were outlined by Dr. H. P. Young of the Vermont Agricultural Experiment Station; soil types as they affect farm economy in the eastern highland of Connecticut were described by Professor C. I. Hendrickson of the Connecticut Agricultural College; part-time farming in Massachusetts was treated by Professor David Rozman of the Massachusetts Agricultural College; and some of the problems faced by farming communities of low agricultural productivity in southern New Hampshire were analyzed by H. C. Woodworth of the University of New Hampshire. Dr. H. C. Taylor outlined the comprehensive survey of rural life in Vermont now being undertaken under his direction by the Vermont Commission on Country Life, and Dr. J. K. Wright explained the purpose of the population studies of New England recently initiated by the American Geographical Society. Multigraphed texts of these papers were subsequently distributed to those who attended the session.

The Prairies: A Region of Dual Climax Vegetation. To the pioneers beyond the Appalachians the prairies presented an economic problem, and their settlement was delayed until it was proved that grasslands could be converted into profitable farms. For the botanist the problem of the prairies is still unsolved. He has tried to explain their origin and persistence on the basis of a variety of conditions existing in the past or present. The extent of the prairies has varied in accord with the climatic changes following the retreat of the ice sheets and is probably still in a period of adjustment. Consequently examples cited in explanation of the existence of prairies are of little value if peripherally located. Central Illinois and Iowa form the heart of the prairies. Within this region woodlands and grasslands occupy adjacent positions, and each tends to perpetuate itself. Philip M. Jones in "The Origin of the Prairie" (*Science*, No. 1710, Vol. 66, 1927, Oct. 7, pp. 329–330) attributes their formation to rapid drainage at the close of the ice age, and Arthur M. Miller in "Origin of the Prairie" (*Science*, No. 1722, Vol. 66, 1927, Dec. 30, pp. 655–656) regards them as an artificial extension of the xerophytic grasslands of the Great Plains caused by the grazing of the buffaloes before the arrival of the white man. Both consider the prairie a subclimax vegetation, in which case its remarkable persistence might be accounted for by the formation of a thick mat of roots almost impenetrable to seeds. In contrast to these theories B. Shimek in "The Persistence of the Prairie" (*Univ. of Iowa Studies in Nat. Hist.*, Vol. 11, 1925, No. 5, New Ser., No. 90, pp. 1–24) cites the recurrence and persistence of prairie vegetation where the turf was broken along the right of way of railroads in central Illinois and its development in railroad fills where new land was exposed to plant invasion. Similarly, an abandoned cornfield in Iowa, exposed to both prairie and woodland influences, gradually reverted to its original prairie state. These examples are all located in the center of the prairie country.

Previous authors have assumed that the prairies had a definite, predestined climax vegetation. Henry C. Cowles in "Persistence of Prairies" (*Ecology*, Vol. 9, 1928, pp. 380–382) suggests the possibility of two climax vegetations, forest and prairie, existing side by side. Some minute factor in the past may have determined the presence of trees or grass. Gradually each type of vegetation has evolved a type of soil adapted to its own reproduction. Passing centuries have accentuated these differences, and the existence of the dual climax vegetation has become more firmly established.

EUROPE

The Recent Colonization in Macedonia. To assimilate nearly a million and a half refugees into a nation of only five millions was the terrible problem faced by the Greek government at the close of 1922. A large share of the burden, however, was assumed by the League of Nations, acting through the Greek Refugee Settlement Commission. This commission has made Macedonia the principal center of colonization. Mr. Charles P. Howland, in his capacity as Chairman of the Commission, writes: "More than four-fifths of the lands allotted to refugees are in Macedonia, for hundreds of years the scenes of massacre and carnage and the breeding ground of wars, and the Greek population in Macedonia has been raised from 513,000 to 1,277,000; more than 1,500 villages have been built, each containing from 100 to 500 families" (Greece and Her Refugees, *Foreign Affairs*, Vol. 4, 1926, pp. 613–623; reference on p. 622). Details of the changes in composition of the population in

Greek Macedonia, it may be noted, are to be found in the authoritative work of A. A. Pallis "Racial Migrations in the Balkans During the Years 1912–1924" (*Geogr. Journ.*, Vol. 66, 1925, pp. 315–331). Mr. Howland continues: "It is not risky to prophesy that in the course of time the effect of Hellenizing Macedonia will be to destroy brigandage and pillage which have thriven on disturbed political and economic conditions, to eliminate civil or guerrilla war among villages and comitadji, and to reduce appreciably the chances of war between Greece and her neighbors who so often have had or created an excuse for intervening on behalf of non-Greeks in the table-lands and valley-pockets of Macedonia and Western Thrace." The work of the Greek Refugee Settlement Commission is described officially in both French and English in a publication of the League of Nations ("Greek Refugee Settlement," Geneva, 1926). This document is accompanied by two striking maps; one for the whole of Greece shows the location of agricultural and urban refugee settlements, revealing graphically the clusters of colonies in Macedonia, western Thrace, and Crete. The other map, which shows Macedonia alone, indicates by districts the relative number of Greeks, Moslems, Bulgars, and others in 1912 and 1926. The Greek migration, particularly in its geographical aspects, was also discussed by Raoul Blanchard in the *Geographical Review*, Vol. 15, 1925, pp. 449–456, and by Edwin Fels in the *Geographische Zeitschrift*, 1927, pp. 576–588.

The portion of Macedonia which lies north of the international frontier forms the major part of the Yugoslav province of South Serbia. This region has been the scene of a colonizing movement comparable to that of Greek Macedonia, though less spectacular and the object of less public attention in western Europe and the United States. It is described by Dr. Hollmann of Berlin in "Kolonisation und Entwicklung der Landwirtschaft in Südserbien (Makedonien)" (*Berichte über Landwirtschaft*, Vol. 8 (N. S.), 1928, pp. 269–294). By January 1, 1928, 6260 families of colonists, for the most part from the plains of the Bachka and Banat north of the Danube, had been settled in agricultural colonies in South Serbia, and, in addition, 5000 land-poor resident peasants had been given additional land. These lands had been made available through the operation of a variety of forces. Under the Turkish régime a system of land tenure had prevailed which, so far as the peasants were concerned, amounted to virtual serfdom. However, "during the latter years of Turkish rule, the economic position of the landlords had been seriously weakened by the increasing emigration of the Christian population." The Balkan and World Wars saw the departure of most of the Moslems to Turkey. Thus, with the final advent of peace in 1918 and the sweeping away by agrarian reforms of the remnants of serfdom, the rich river valleys and old lake floors of South Serbia stood ready for colonists from central and northern Yugoslavia. Their colonization has been eagerly promoted by the Yugoslav government, partly to relieve the increasing tension of agrarian discontent that has threatened certain overpopulated regions and partly in order that the vulnerable frontier zones facing Greece and Bulgaria may be occupied by a homogeneous Yugoslav population. On the whole this colonizing enterprise has met with success, although in some instances lack of proper planning has resulted in settlements on malarial or otherwise unsuitable ground.

Notes on European Town Studies. American geographers have only recently shown a tendency to give concentrated study to cities as geographic units. In fact, much of our best material in this field has been produced by the non-geographer and may be found as incidental comment in the writings of architects, engineers, social workers, or industrial surveyors engaged in the solution of city-planning, traffic, zoning, and urban trade-expansion problems. European geographers have given the subject considerably greater attention. Their work may be illustrated by the following comments on some recent German and Swiss town studies.

"Hamburg: Eine landschaftskundliche Stadtuntersuchung," by Dr. Friedrich

Schwieker (Hamburg, 1925) describes Hamburg first, in general terms, as a visitor to the city might observe it—the harbor, the inner city, the Alster or inner waterway. These introductory chapters give one an informal picture of the city. The author then proceeds to a systematic study, involving the city's location with respect to its hinterland, its topography, its plan, its buildings, the open spaces such as parks, playgrounds, and the like, the political aspects as related to the business structure, and the distribution of population. The work attempts to analyze the urban community in terms of unit landscapes and succeeds very well. It makes attractive reading for geographer and layman.

Dr. Hans Bobek analyzes the city of Innsbruck and its environmental relationships with the aid of many original charts and maps (*Forschungen zur Deutschen Landes-und Volkskunde*, Vol. 25, Stuttgart, 1928, pp. 225–372). The illustrative material treats of such aspects as population density, the plan of the city, distribution of its industries, character and type of buildings. Thanks to the availability of statistical data by provinces in the neighborhood of Innsbruck, it has been possible for the author to map imports and exports of certain foodstuffs. Likewise, transportation statistics relative to freight and passenger traffic are available, and the author has made the most of them. The volume contains a considerable amount of original interpretation and commends itself to anyone anticipating a detailed, geographic study of an urban center.

Not so elaborate but quite similar in plan to Bobek's study, for which it was possibly a stimulation, is one by Dr. Hugo Hassinger on Basel (Breslau, 1927). The schematic black and white maps are worth noting because they show so well the historical development, settlement, economic aspects, and environmental relationships. Hassinger is convinced that a city has a "physiognomy." This is a phase of urban geography which most American geographers have yet to recognize. Occasional reference has been made to cultural landscapes, but these landscapes have included fairly large regions rather than restricted city areas. Incidentally it may not be amiss to refer to a study on Swiss cities (Gantner's "Die Schweizer Stadt," Munich, 1925) already reviewed in the *Geographical Review* (Vol. 18, 1928, pp. 349–350), in which the city landscape or the physiognomy of cities is beautifully treated through photographs.

Paul Walther, in a dissertation entitled "Zur Geographie der Stadt Zürich" (Zurich, Leipzig, Berlin, 1927) contends that the development of all city plans is dependent upon the topography of the site. Because of the hypothesis which he sets up for himself, he considers the development of Zurich from its founding only to the middle of the nineteenth century, or to the beginning of rail transportation. Inasmuch as modern modes of transportation combined with engineering efficiency have interfered in a sense with the free play of topographic influences upon settlement, he does not pursue his arguments beyond this era.

Dr. Rudolf Martiny, in a monograph entitled "Die Grundrissgestaltung der deutschen Siedlungen" (*Petermanns Mitt. Ergänzungsheft No. 197*, 1928), advances the theory that geographers may view cities morphologically quite as well as physiographers view the earth itself morphologically. However, he recognizes that one must content himself with the morphology of the city plan rather than with the human element, although one may well include buildings and other cultural works of man. He then proceeds to a discussion of the evolution of settlement from the village to the metropolis, analyzing numerous plans as illustrated by European centers. Diagrams are presented to show radial, rectangular, circular, accretionary, triangular, and still other plans. These plans are further analyzed in terms of business streets, decorative streets, and other types of highways. The decorative streets, for example, are represented by such well known avenues as Unter den Linden, connecting the royal palace with the parliament buildings, or streets that terminate in plazas in front of churches, theaters, or other public structures.

Geographers contemplating urban studies may well profit from a reading of these publications. The city represents a climax form of civilization and as such offers a rich field for geographic interpretation.

Eugene Van Cleef

Fruits and Vegetables for Paris. Paris has a population well over two and three quarter millions, and the *département* of the Seine a total of over four and a half millions. Mademoiselle Suzanne Demangeon in "L'approvisionnement de Paris en fruits et légumes" (*Ann. de Géogr.*, No. 206, Vol. 37, 1928, pp. 97–121) says, "It is well to note, however, that the needs of the capital have increased proportionally much faster than the number of the inhabitants. It is here that a new but very important factor arises; the raising of the standard of living among the working people. Fruits, regarded a few years ago as luxuries reserved for a small number of the well-to-do, have become common and are today to be found in the smallest markets." To serve this voracious center of population, fruits and vegetables are gathered from all parts of France, from Belgium, and from North Africa. This variety of origin has been made possible, first, by a market which demands fresh supplies at all times of the year and, secondly, by modern developments in refrigeration and express service.

About 90 per cent of the fruits and vegetables found in the Halles have their origin in France. Some of the largest market gardens in the world are located in the plain of Avignon, where a highly specialized industry is producing 10,000 to 15,000 tons of fruits and vegetables annually. In places the Mediterranean littoral appears to be one continuous market garden. Other centers are in the plain of Roussillon, which specializes in artichokes and peaches; in protected spots along the coast of Brittany and Normandy; in the valleys of the principal rivers; and around Paris, where an inner circle of intensive cultivation, often under glass, is surrounded by an area where field crops are raised. The greenhouses of Belgium supply Paris with five-sixths of her forced fruits.

Moroccan vegetables come on the Paris markets three weeks to a month before those from European localities, the price obtained being sufficient to offset the high cost of transportation. In Morocco, market gardening is in its infancy; and the shipments consist principally of tomatoes, peas, and beans—vegetables capable of standing the five-to-eight-day journey. Fruit growing is still in an experimental stage. The market gardens of the Casablanca area, which are described by J. Goulven ("Casablanca, centre primeuriste," *Rev. de Géogr. Marocaine*, Vol. 5, 1926, pp. 61–71) enjoy the advantages of excellent soil, fall and spring rains, freedom from low temperatures, and sufficient water for irrigation. The three hundred market gardeners of Casablanca are French, Spanish, or Italian colonists who are pursuing their former calling in a new environment. The production of fresh vegetables amounted to 100 kilos in 1920, and by 1925 it had grown to 640,733 kilos valued at over half a million francs. As markets are found and transportation conditions improve, market gardening along the Moroccan shore will be capable of extended development. (Louis Le Barbier: Le Maroc agricole, Paris, 1927.)

Paris has been receiving Algerian produce for sixty-five years; and since 1900 there has been a real, though fluctuating, development, which now amounts to an annual production of over 100,000 tons. Good soil and climate, aided by governmental research and combined with the use of modern methods by the colonists, are responsible for the great variety and excellent condition of the fruits and vegetables exported from this colony. The centers of cultivation are scattered along the shore near Algiers, Constantine, Oran, Philippeville, and Bone; each specializing in whatever fruit or vegetable is most suited to the locality. The principal crops are table grapes, citrus fruits, plums, medlars, figs, peas, beans, artichokes, tomatoes, and asparagus. Transportation here too is the prime difficulty. Furthermore, Algerian products come into competition with Spanish and Italian exports. Understandings have been reached with French railroads, and coöperatives have been organized which supervise packing, production, and selling. Canneries are being established to take the surplus or the whole crop when prices are low. (Edouard Payen: Les primeurs et les fruits dans l'Afrique du Nord, *Renseign. Colon.* (*Suppl. à l'Afrique Française*), 1928, pp. 583–603.)

AFRICA

The Human Geography of Northern Libya. Readers of the *Geographical Review* will recall an article by Hans Wilson Ahlmann in the January, 1928, number in which the forms of settlement are studied in certain type regions in Norway, Denmark, Germany, Italy. Taken together, the regions chosen for intensive examination furnish a cross section through Europe from north to south. In the *Geografiska Annaler* for 1928 Ahlmann has published a monograph entitled "La Libye septentrionale: Études de géographie physique et humaine." Here the analysis of settlement is carried beyond the bounds of Europe. Ahlmann conceives of northern Libya as constituting the southern frontier of the great area of "Old World civilization west of the Nile." Beyond the semiarid steppes which fringe it to the south, the drought of the Sahara interposes an impassable barrier against the farther advance of cultivation. Along this marginal zone the occupation of the land has assumed forms in some ways comparable to those that have been evolved along the opposite frontier of European civilization in northern Scandinavia. For example, in both regions settlement is dispersed in the extreme, and in both transhumance is practiced. Ahlmann's latest study thus logically completes the cross section through the great area of European civilization that was begun in his earlier researches.

Before the Italian occupation of Libya such a full program of research as that which Ahlmann set himself could not have been carried out. Under Turkish rule Tripoli and Cyrenaica were among the least-known quarters of Africa. Behind the immediate coastal belt along the Mediterranean spread wide expanses of unexplored and half-explored country. While there is still much to be learned, the facilities offered by Italian officials and scientists toward the successful conduct of field work in the winter of 1926–1927, together with the data provided in the published works of Italian scientists and in Italian statistical compilations, have made it possible for Ahlmann to produce an unusually well-rounded regional monograph.

Ahlmann's foremost interest is "the study of settlements (*établissements humains*) considered as the expression of the relations between nature and culture." The first part of "La Libye septentrionale," accordingly, is devoted to the natural environment: land forms, climate, drainage, and vegetation. In this connection it may be noted that Ahlmann's study is supplemented for Tripolitania by Dr. Leo Wittschell's monograph "Klima und Landschaft in Tripolitanien" (*Veröffentl. Geogr. Inst. der Albertus-Universität zu Königsberg*, Vol. 10, Hamburg, 1928), with climatic tables and maps and some excellent photographs of types of landscape.

In Part II the rôle of historical forces in producing existing cultural conditions is adequately recognized in a brief "history of the human geography of northern Libya." The most original paragraphs in this clear outline are given over to an attempt at determining the extent of the cultivated area of Cyrenaica in antiquity. Ahlmann assumes that the climate of northern Africa has not materially changed within the last two or three millennia. He also assumes that the great majority of the existing wells and cisterns in Cyrenaica were constructed before the Arab occupation. The Arabs "confined themselves to what antiquity had bequeathed to them" and did not undertake the digging of wells or building of cisterns. Consequently Ahlmann holds that the location of wells, cisterns, and springs gives a fairly precise notion of those areas that were most prosperous agriculturally under the Greeks and Romans.

On the basis of a map showing watering places Ahlmann deduces the general limits of ancient settlement.

The areas occupied by sedentary folk were unquestionably larger than they now are. Ahlmann agrees with Professor E. F. Gautier in regarding the introduction of the camel into northern Africa (toward the close of the period of Roman rule) as an event of the utmost historical significance, in that it made possible the practice of nomadism in hitherto unoccupied tracts. The camel assured to the nomadic Arab invaders of the tenth century preponderance over the settled folk, a preponderance that would account in large measure for the cultural stagnation of northern Libya in medieval and modern times.

The last half of Ahlmann's work deals with the human geography of northern Libya at the present day: Part III with the actual status of native culture, and Part IV with forms of settlement. Stock raising and agriculture are by far the most important industries. Urban centers are small, and urban industries insignificant.

One important point stressed by Ratzel, but here made especially clear by the citation of numerous illustrative examples, is the absence of any sharp line of cleavage between the nomadic and sedentary elements in the population. The two modes of life merge almost imperceptibly into each other. At one end of the scale are the tent-dwelling nomads, constantly on the move from pasture to pasture with their sheep and camels; at the other are the growers of fruit trees and cultivators of small garden plots, dwellers in compactly-built villages where water may be obtained. But between these two extremes are many intermediate states of "seminomadism" and "quasisedentation." Even agriculture is by many practiced on a nomadic basis, the same family going now here, now there, to find land where there is sufficient moisture for raising crops. Nor is the status of nomadism or sedentation necessarily a permanent one. A man or a family or a tribe may turn from one to the other mode of life with changes in natural, or social, or political circumstances.

Ahlmann's chapters on forms of settlement are illustrated by two maps showing the distribution of population in northern Cyrenaica and northern Tripolitania. By the use of dots and squares the distinction is brought out between inhabitants of houses, "quasisedentary" inhabitants of tents, "seminomadic" inhabitants of tents, and cave dwellers. A tabulation emphasizes interesting correlations not only between the density of population as a whole but also between the various categories of settlement and climatic zones. This reveals the fact that 70 per cent of the total population of northern Libya live in the subtropical coastal belt. "The remaining 30 per cent are scattered over the interior of the enormous arid and semiarid tracts which reach the coast at the Great Syrtis only."

Lost Oases of the Libyan Desert. In the latter part of 1927 Douglas Newbold and W. B. K. Shaw made a journey in the southern Libyan Desert in search, amongst other things, of the legendary oasis of Zerzura. Interest in the "lost" oases of the desert, lost in the sense that they were unknown to the civilized world, has been stimulated by Hassanein Bey's "rediscovery" of Owenat and Arkenu in 1923 while, in 1924–1925, Prince Kemal el-Din in company with Dr. John Ball discovered the isolated oasis of Merga, 75 miles to the northwest of Bir Natrun in the Anglo-Egyptian Sudan. The direction of Merga—or Nekheila, to give its Sudanese name—had been pointed out to Mr. Newbold on his journey to Bir Natrun in 1923 (see the note "Exploration in the South of the Libyan Desert," *Geogr. Rev.*, Vol. 15, 1925, p. 307). On the journey of 1927 Mr. Newbold visited Merga and a previously unknown water-bearing depression 20 miles to the northeast and thence cut across the unexplored area between Merga and the oasis of Selima on the Arbain Road (compare T. A. Leach: The Selima Oasis, *Sudan Notes and Records*, Vol. 9, 1926, pp. 37–49), a distance of 275 miles in which no oasis was found.

Search for oases has depended largely on current reports and traditions among the

Arabs. The application of scientific theory has been made by Dr. Ball in his paper "Problems of the Libyan Desert" (*Geogr. Journ.*, Vol. 70, 1927, pp. 21–38, 105–128, and 209–224). In the last fifteen years our knowledge of the Libyan Desert has been vastly increased. There now are sufficient altitude determinations available for the drawing of a contour map of the desert (see review of the "Atlas of Egypt" elsewhere in this number of the *Review*) with contours at 100-meter intervals. Furthermore, there are sufficient observations on water levels deriving from artesian sources to enable Dr. Ball to construct a map of the static water surface underlying the desert. By superimposing the one map on the other various deductions can be drawn. For instance, Dr. Ball concludes that it will not be possible to increase the scant water supply of the Mediterranean littoral of Egypt by sinking deep wells as has often been urged. Here we shall refer only to the application to the problem of lost oases.

Every oasis, says Dr. Ball, must depend either on springs fed by local rainfall, in which case, like Owenat and Arkenu, it probably lies near mountains of considerable height, or it must depend on underground supplies and therefore lie in a depression wherein the surface of the ground and the static water level are practically coincident. The existence of oases fed by local rainfall in the unknown areas of the desert is considered improbable. In the latter case two possible areas exist, one in the unknown northwest and one in the southeast, the southern area offering the more probable locus of Zerzura. In a later paper, "Remarks on 'Lost' Oases of the Libyan Desert" (*Geogr. Journ.*, Vol. 72, 1928, pp. 250–258) and on the basis of an examination of fifteenth-century Arabic manuscripts, Dr. Ball finally concludes that Zerzura has "no more existence than the philosopher's stone": it is merely a variant on the old treasure stories; though this does not mean that oases hitherto unvisited do not exist. This second paper by Dr. Ball follows a discussion by Mr. W. J. Harding King (Lost Oases of the Libyan Desert, *ibid.*, pp. 244–249) in which he expressed the opinion that local conditions may sometimes permit the accumulation of water from local rainfall and the existence, at least for a time, of oases in the areas from which they have been ruled out by Dr. Ball.

Mr. Newbold takes up the question from data obtained in the Sudan. Such data encourage belief in the existence of three or possibly four lost oases in the southern Libyan Desert. One, possibly the Zerzura of legend, he believes will be found in latitude 21° 30′ N. and longitude 27° 20′ W. or within about forty miles to the southwest of that point. One reported visited by Arabs in 1904 and 1916 he places about forty miles northeast of Merga, another west or southwest of Bir Natrun.

Olive Culture in North Africa. The olive is peculiarly the tree of the Mediterranean—a "measuring rod" of Mediterranean flora, as Marcel Clerget has aptly remarked (Marcel Clerget: La géographie de l'olivier en Méditerranée, *Bull. Soc. Royale de Géogr. d'Egypte*, Vol. 14, 1926, pp. 1–16). The great centers of olive cultivation passed in early times from east to west. Today the chief olive-growing countries are Spain, Italy, and Greece; but it is interesting to note the revival of the cultivation in northern Africa.

Under Carthage and Rome the African shores of the Mediterranean were well endowed with olive groves; but during the invasions of the Middle Ages the trees that were not actually destroyed largely died out through the filling of wells, the destruction of irrigation systems, and the partial annihilation of the inhabitants. At the beginning of the modern period the orchards were small, old, and uncared-for; the low-grade product had a local consumption only; the natives, forced to a nomadic life by the series of invasions, had lost their skill at this specialized form of agriculture; and there was no organized export or sale of the fruit or oil.

The establishment of law and order and the subsequent colonization of North Africa by the French have resulted in the introduction of new methods of cultivation, the organization of commercial interests, and the rapid development of the industry.

Most of the business is in the hands of native growers, whose economic status has thus been raised. In some cases nomadic tribes have been transformed into settled communities. Although most of the trees are held by native proprietors (88 per cent for Tunis in 1926), there is a marked rise in the number cultivated by colonists, who are increasing their holdings at a faster rate than the natives. The situation is briefly outlined by J. Ladreit de Lacharrière in an article in *Africa* (La renaissance de l'olivier et la propriété foncière dans l'Afrique du Nord, Vol. 1, 1928, pp. 463–477), the new journal of the International Institute of African Languages and Cultures.

In Morocco, where the industry is hardly developed on a commercial scale as yet, the natives own over 95 per cent of the trees but employ old methods of culture such as beating the fruit from the trees with sticks. Consequently, the fruit is used locally or made into oil. Around Fez, where the olive area is increasing, there is competition with other fruits; to the south (Marrakesh), where irrigation is absolutely necessary, the industry is in an experimental stage. Morocco is favored by having a sedentary population, favorable soil, and climatic conditions; but the introduction of capital and modern methods is greatly needed.

The "Forest" of Constantine is typical of the large closely planted areas which are to be found under native cultivation in Algeria. The Department of Oran, where the larger part of the colonists live, is gradually forging ahead and took second place in the 1924 Algerian production. The native owns most of the trees, and his methods are more advanced than they are in Morocco; but the colonists with their intensified methods are making the more rapid progress.

Tunis shows the greatest extension of olive culture. Here the number of trees has doubled since 1885. The most important single development is that at Sfax where, through the initiative of Paul Bourde, the number of trees has grown from 380,000 to over 4,058,000. Favorable soil, natives accustomed to olive culture, the advantageous terms of the Mgharsa land contract, the occurrence of phosphates in the neighborhood, large areas of available land, official encouragement, and the presence of French capital and organization have all conspired to transform the region.

A study of the potential olive areas of Cyrenaica and Libya (Armando Maugini: Olivicoltura nella Tunisia e nella Libia, *L'Agricoltura Coloniale*, Vol. 21, 1927, pp. 1–5, 46–59, and 83–94), leads to the conclusion that northern Tripolitania is as well suited to olive culture as southern Tunis but that economic, social, and financial conditions are so different that until there has been further study it will be impossible to duplicate the French successes. At present the value of the olive is unappreciated by the native.

With regard to world trade in olive oil, North Africa is at a disadvantage, since a selling organization is largely lacking. In general, the best oil is exported—often poorer oil being imported to fill the demands of the natives. Lack of coöperation has resulted in a situation where Italy buys oil from Tunis to sell to France.

E. Payen and J. Ladreit de Lacharrière have given a full description of the industry in North Africa in *Renseignements Coloniaux* (*Supplément a l'Afrique Française*), No. 6, 1928. Figures through 1926 are obtainable therein. *L'Économiste Française* for November 3, 1928, discusses the coming olive harvest, which several years of drought will probably render small.

ASIA

Rainfall and Floods in Northern Bengal. Seventy-seven per cent of the total annual precipitation in North Bengal falls during the months of June to September inclusive, when the southwest monsoon prevails. It is the amount and distribution of this monsoon rainfall which in normal years determines the prosperity of the whole of North Bengal and in abnormal years controls the occurrence of floods in the same region. A study of this relation between rainfall and flood has been made by Mr. P. C. Mahalanobis on behalf of the North Bengal Flood Committee (Report on Rainfall and Floods in North Bengal, 1870–1922, Government of Bengal, Irrigation Department, Calcutta, 1927).

During the period of summer rains cyclonic storms of slight to moderate intensity form over the Bay of Bengal, advance northward in the general stream of southwest air, and strike the Bengal and Orissa coasts. Lacking in severity as these depressions usually are, they do, nevertheless, deliver extraordinarily heavy rains along their paths. It is these storms, providing excessively heavy local rainfall in addition to the abundant monsoon precipitation, which cause the floods. Every great flood in North Bengal for the past fifty years has been of this origin. Almost all of the floods occur toward the middle or latter part of the rainy season. In June the rains are normally not as abundant and the ground is less saturated. There are no indications of a cyclic period in which great floods are repeated, nor does the interval of years between great floods seem to have any relation to the intensity of successive floods.

The author is not optimistic concerning the prevention of future floods. The basic difficulty in correcting the situation is to be found in the low-lying nature of the district, which cannot be remedied by artificial means. Retarding basins are largely ineffective because floods occur where there are the heaviest local rains and are not occasioned, except in a minor supplementary way, by water from adjoining areas. Embankments along the watercourses are only temporary expedients and are likely in the long run to make the situation worse by raising the river beds. The fundamental problem is to facilitate the quick removal of excessive waters from local areas. In so far as possible, removal of all artificial obstructions such as railway or road embankments is to be recommended together with the construction of sufficient culverts and openings for the passage of flood waters. Improvement of existing river channels is likewise recommended. The inhabitants of the flood areas should be instructed to make provision for flood contingencies. Houses should be located on high ground whenever possible, and raised platforms need to be constructed where human beings can take refuge in time of flood. Villages should be advised to construct raised mounds to which grain and valuable property can be removed in time of flood peril. The Indian Meteorological Service could be of great assistance in preventing loss of life and property if it would undertake to issue flood forecasts and warnings.

A set of 32 maps accompanies the report, a few of them setting forth conditions of normal rainfall distribution and the general flood subdivisions; but most of them illustrate abnormal rainfall and flood areas in specific years.

Glenn T. Trewartha

The Future of India as a Wheat Exporter. India will not become a wheat exporter of any great importance according to the conclusions reached in "India as a Producer and Exporter of Wheat," one of the series of "Wheat Studies" that is being published by the Food Research Institute, Leland Stanford University (Vol. 3, 1927, pp. 317–412). In the earlier years of India's export of wheat it was expected that she would be able to supply all of England's requirements, and it was even hoped that India might become the world's leading wheat exporter. Though a rapid increase in exports occurred during the decade from 1870 to 1880, the expectations and hopes have never been realized. During the next decade the trade apparently reached its peak, and in subsequent years it has been almost impossible to determine the trend of exports. In certain years of especially favorable weather in India, wheat exports have been large, though not much greater than the exports of the decade 1880–1890 and never of a magnitude to compare with the usual exports of the United

States, Canada, Russia, and Argentina, or with the exports of Australia in more recent years. In other years of a less favorable monsoon the exports have been greatly reduced or have disappeared entirely. In the years immediately preceding the Great War there seemed to be an upward trend to exports, but in some of the years since the War it has been necessary to import wheat and wheat flour into India.

The authors of this study are of the opinion that the present wheat production of India, about 350 million bushels a year, may be increased during the next twenty-five or thirty years by 100 million bushels, one half from better methods and one half by more irrigation. It seems certain that the irrigated areas especially in the northwest will be extended; and it is conceivable that an increase in production may be achieved through improvements in methods, but the obstacles obviously are very great.

Even if increase in production is possible, however, it will be of no importance to the export trade, for consumption within the country is expected to increase as rapidly, partly through growth of the total population and partly through an increase in per capita consumption due to a higher standard of living and especially to the movement from the villages to the towns and to the development of industries. Only in occasional years of especially favorable weather will India be able to export wheat in significant quantities.

This study is more than an analysis of India's position as a producer and exporter of wheat. The authors have included a comprehensive statistical section with many tables on irrigated areas and on production, per-acre yields, exports, imports, and prices of wheat. They have also included a survey of the relief, climate, and soil of India, of general agriculture and crops, of the agricultural population, its methods of cultivation, implements, and cultural background as it influences agriculture, of population trends, of irrigation practices, and of the growth of industry. In short, the study is a good general presentation of the geography of Indian agriculture.

John E. Orchard

The Earthquake Problem in the Reconstruction of Tokyo and Yokohama. Before September 1, 1923, Tokyo, with its narrow streets and winding canals, was still an ancient oriental city superficially modernized. But, as Mr. J. H. Ehlers puts it, "with the earthquake the last vestige of old Yedo disappeared in the smoking ruins of the ancient hostage camp" (Reconstruction and Development of the Tokyo-Yokohama District, *U. S. Dept. of Commerce Trade Promotion Ser. No. 69*, 1928). A quarter of a million houses were burned; about 60 per cent of the floor space of the city was destroyed. Reconstruction rather than repair was called for, with the opportunity for introduction of radical improvements. Of particular interest is the response to the bitterly learned lesson of special planning against earthquake liability. As Mr. Tachu Naito says, "Not infrequently disasters from terrible shocks were experienced, but it seems that the awful memory was soon forgotten and our people continued to live and thrive in flimsy edifices." He advances the principle of rigid construction with a natural vibration period smaller than that of any conceivable great earthquake (Earthquake-proof Construction, *Bull. Seismol. Soc. of America*, Vol. 17, 1927, pp. 57–94). The matter is highly technical; and, while much has been learned through a study of the strains exhibited in the 1923 earthquake, it remains "to find a definite solution in accordance with the fundamental rules of dynamics."

Of even greater importance is provision against fire. The reconstruction plans lay out certain fireproof zones and call for the establishment of open spaces as refuges and for wide streets. It is proposed to increase the area devoted to streets from 11.6 per cent to over 25 per cent. At the same time buildings are restricted to a maximum height of 100 feet. Tokyo, a city of two and a half millions in 1922, reduced to one and a half millions in 1923, has already over two millions again. This means a serious transportation problem; and the introduction of subways is being considered, itself a problem in an earthquake zone. The new city plans also call for zoning into commercial, industrial, and residential areas.

Plans for Yokohama are similar, though the area to be reconstructed is much smaller than in Tokyo. Special difficulties arise from the fact that much of Yokohama has an irregular topography. Maps showing development plans of the two cities not included in Mr. Ehlers' report may be seen in the Industrial Machinery Division of the Bureau of Foreign and Domestic Commerce in Washington, D. C. A map outlining the reconstruction scheme for Tokyo also appears in the official publication "The Great Earthquake of 1923 in Japan" (Bureau of Social Affairs, Japan, 1926). This volume with its eloquent illustrations gives an impressive account of the disaster and throws into relief the really great recovery that has been made. According to figures supplied by Mr. Ehlers, Tokyo in 1922 had some 10,000 factories (employing more than 5 persons each): 70 per cent of the factories, representing a production value of 80 per cent, were destroyed; by 1926, however, 70 per cent recovery in production had been made. Yokohama has largely regained its former volume of trade but has not participated in the great advances shown by Kobe and Osaka. Yokohama, however, is unquestionably the most logical center for the silk trade, and silk is still the most important export of the country (see Mr. Orchard's paper elsewhere in this number of the *Review*).

Intensity of Rainfall in the Philippines and Ceylon. What constitutes a heavy rainfall? "There is no agreement among the meteorologists, as to the maximum and minimum value to be assigned to the duration and to the amount of precipitation in the classification of heavy rainfalls. The character of rain varies in different countries, and its effect upon agriculture as well as upon drainage systems is different. One of the reasons why the American engineers gave so much study and consideration to the separate system and departed from the traditional English system of combining house sewage and storm water is because the English rains are more frequent, but less intense, than the American rainfalls. These, being heavier, require larger storm-water drains for like topographical conditions and afford more vigorous flushing action in the sewers." This question of rainfall intensity, of such obvious importance to the city engineer, is considered by the Rev. Miguel Selga, S.J., in "The Intensity of Rainfall at Manila" and in "The Intensity of Rainfall in the Main Cities of the Philippines" (Weather Bureau, Manila Central Observatory, 1928). He deals with particular cases; but he has examined the literature on the subject, and his methods and conclusions are intended as a guide for similar studies elsewhere.

It is not possible to obtain an accurate idea of intensity from the regular morning and evening precipitation readings; a continuous record on which small amounts of rain and short periods of time can be registered is required. The study for Manila is based in the main on a homogeneous series of pluviograph records over a period of 20 years. All rainfalls of intensity greater than 0.29 mm. per minute during three hours are tabulated. There are graphs and tables of duration, frequency, and mean intensity and the probability of heavy rains. Lists of excessive monthly, daily, and hourly rainfalls since 1865 and excessive hourly rainfalls since 1886 are also given. The study of the subdivisions of each heavy rainfall in intervals of five minutes shows that it is unusual for a heavy rainfall to keep a uniform rate for a long period, that in the most intensive storms the highest intensity occurs near the beginning of the heavy shower, and that the maximum intensity for short intervals is not much higher than the intensity sometimes measured in extratropical thunderstorms.

Since no pluviograph records exist for the Philippine cities of Baguio, Vigan-Laoag, Iloilo, Cebu, and Zamboanga, a day became the unit of time employed in studying the rainfall intensities of these cities. Dissimilar climatic conditions made it necessary for the author, after closely examining the records, to select a standard value for the lower limit of excessive precipitation. Making a count of all rainfalls above this standard from 1910 to 1927, he shows the relation between heavy rains and their duration for a specific locality and indicates the provision to be made against heavy showers and protracted rains.

For Ceylon, where intense rainfalls are usual and their duration is chiefly important to the construction engineer, H. Jameson has prepared a paper (Heavy Rainfall in Ceylon, *Trans. Engineering Assn. of Ceylon*, 1927) in which he presents tables giving the maximum total precipitation on *n* consecutive days ($n = 1, 2, 3$, etc.) for 25 selected stations over a period of 15 years. Experimentally the author has attempted to correlate these heavy rains with the three characteristic types of precipitation, i. e. monsoon, "depressional," and local circulation.

An Extraordinary Seiche in the Sulu Sea. All who have business in Puerto Princesa, capital, and mahogany-shipping port of Palawan, P. I., know its *mare loco*, its crazy tides. The waters of the bay are in a constant state of rhythmic vibratory motion, the period being approximately one hour and a quarter, or one-tenth the average period of the semidaily lunar tide, which it almost equals in regularity, the amplitude varying from a few hundredths of a foot to three or four feet. Other places along the east, or Sulu Sea, coast of Palawan show similar seiche movement, but it is best exhibited between Bahía Honda (latitude 10° N.) and Bahía de las Islas (latitude 9° N.), reaching its "acme of perfection" in Puerto Princesa. Simultaneous observations at ten stations in the Puerto Princesa bay show that a somewhat irregular movement of small amplitude near the entrance is transformed as the head is approached into a regular undulation of considerable magnitude (Fig. 1). Seemingly it is "due to the impression of the relatively weak, and for most part unnoticed, oscillations outside upon the body of water in Puerto Princesa, with a frequency corresponding approximately to its own natural period of oscillation."

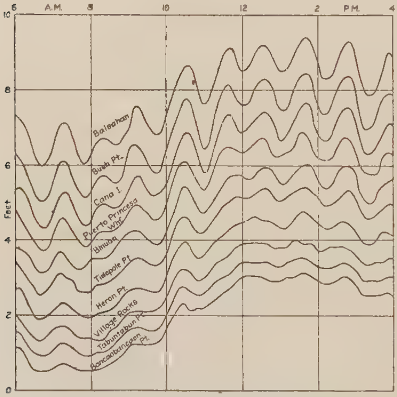

FIG. 1—Tide curves showing simultaneous seiche movement observed at ten stations in Puerto Princesa bay on October 23, 1918. (Reproduced from Fig. 4 of Mr. Haight's paper in the *Military Engineer*.)

The depth of the Sulu Sea is for the most part 1000 fathoms or more; off the Palawan coast, however, there is a shoal area of 20 fathoms with a break in the shelf-like bank off Puerto Princesa. The theory has been advanced that the seiche is set up by strong currents in the Sulu Sea striking the edge of the banks and forcing the water surface to rise, thus disturbing its equilibrium. Mr. Frank J. Haight, who describes these "Unusual Tidal Movements in the Sulu Sea" (*Military Engineer*, Vol. 20, 1928, pp. 471–475), believes that if meteorological data were available the usual explanation, variations in atmospheric pressure, would be forthcoming. The problem, however, is admittedly complex.

POLAR REGIONS

A Demographic Inquiry into the Eskimo Population. A statistical study, "Alcuni dati demografici sugli Esquimesi," has been made by Giorgio Carega (*Metron*, Vol. 7, 1928, pp. 52–111) to determine the causes of the decline of the Eskimo population after its contact with Europeans and of its subsequent increase in Greenland and, during the last twenty years, in Alaska also. Most of the article naturally deals with Greenland statistics, which are much the fullest and extend over the longest term of years. An examination of the censuses there from 1805 to 1915, of the birth and death statistics, the age classes, and the proportion of mixed bloods to pure bloods leads the author to conclude that the Eskimos were declining in numbers even before their contact with Europeans owing to a physiological weakness that lowered their reproductivity and shortened the average span of life, making the birth rate lower than the death rate. Their increase during the past seventy-five years he attributes partly to the improvement in the social and economic conditions brought about by the Danish government, but mainly to the increasing admixture of European blood, which he maintains introduces a strengthening element that raises the birth rate, lowers the death rate, and increases longevity. That the birth rate in South Greenland has always been higher than in North Greenland he would also ascribe to a little foreign blood introduced through the absorption of the ancient Icelandic colonists; and he therefore joins issue with Søren Hansen's theory that all the colonists who survived the attacks of the Eskimos perished through starvation or disease.

A brief analysis of the incomplete data from Labrador and Alaska serves to confirm him in these deductions. It would seem to the reviewer, however, that while we might agree that an admixture of white blood is beneficial to the Eskimos, there are too many other factors relevant to the inquiry (e. g. the onslaught of European diseases and the widespread disturbances of population before the compilation of any censuses) which the author has not weighed sufficiently and which render his theories doubtful.

D. Jenness

OBITUARY

Gunnar Andersson. Karl Filip Gunnar Andersson, professor of economic geography in the Commercial Academy of Stockholm and corresponding member of the American Geographical Society, died on August 5, 1928, in his sixty-third year. For a quarter of a century Dr. Andersson had acted as secretary of the Swedish Society of Anthropology and Geography: he was editor of the Society's magazine, *Ymer*, and, with Axel Wallén, editor of the *Geografiska Annaler*. Full obituary notices appear in *Ymer*, Vol. 48, 1928, pp. 193–201, and the *Svensk Geografisk Årsbok* for 1928, pp. 204–210.

Dr. Andersson early devoted himself to plant geography, engaging especially in studies of the evolution of the postglacial vegetation of Sweden. He prepared a paper on "The Climate of Sweden in the Late Quaternary Period" (*Sveriges Geologiska Undersöknings Årsbok*, 1909) for the Eleventh International Geological Congress meeting in Stockholm in 1909 and furnished the introduction to the volume put out by the Congress "Die Veränderungen des Klimas seit dem Maximum der letzten Eiszeit" (1910). Dr. Andersson became increasingly interested in the economic side of geography, to which he made some excellent contributions including "Vårt Daglica Bröd" (3rd edit., 1918), "Australien, Natur och Kultur" (1915), dealing with the possibilities of Australia as a white man's country, and the chapter on "Sweden's Natural Resources in Relation to Industry" in the volume "Industry in Sweden" (1927).

GEOGRAPHICAL REVIEWS

Greenland and Its Physical Geography

M. Vahl, G. C. Amdrup, L. Bobé, and A. S. Jensen, edits. **Greenland.** Vol. 1, **The Discovery of Greenland, Exploration and Nature of the Country.** ii and 575 pp.; maps, diagrs., ills., bibliogr. Published by the Commission for the Direction of the Geological and Geographical Investigations in Greenland. C. A. Reitzel, Copenhagen; Oxford Univ. Press, London, 1928. 11 x 7 inches.

Denmark, it would seem, has discovered a new use for colonial territory. While other nations find in their colonies an outlet for surplus population or a source of raw materials or a market for home products, she has found in Greenland a vast laboratory, preserved for her own people and for properly accredited visiting scientists. Norway, one might add, appears to be following a similar course in Svalbard.

As a laboratory for the study of various problems in physical geography Greenland offers some exceptional facilities. Glaciology is the foremost problem. The inland ice, as it was first termed by Rink, is impressive alike in its enormous extent—estimated at some 1,869,000 square kilometers—and in the infinite variety of glacial phenomena presented along its 7000-to-8000-kilometer circumference. We have known of its vast extent from the days of the "King's Mirror," at the beginning of the thirteenth century; but scientific investigation began only with A. E. Nordenskiöld in 1870: in 1886 Peary began his series of ice journeys, and Nansen made the first crossing in 1888. Many subsequent crossings and penetrations still leave unanswered the fundamental question: Is the surface form of the ice determined by the contour of the ground, or is the form dependent rather on the physical properties of ice? This has a bearing on the question of origin; for, if the former is the case, then altitude with its influence on temperature and precipitation is of essential importance. Olaf Kayser, who contributes the chapter on the inland ice in this volume of "Greenland," concludes "that it is extremely probable that in the main it is the properties of ice which determine the broad features of the surface form." The arguments in favor of this conclusion include the hypsographic curve worked out by Meinardus; which, moreover, is in general agreement with the formula for a plastic mass.

Closely related is the question of the present condition of the ice sheet. Kayser expresses the view that the ice margin is now in the main stationary; advances and retreats have been observed, but no law has yet been established. Drygalski considers that the ice is in a state of retreat. One of the arguments advanced by him is the phenomenon of the cryoconite holes occurring on the western side of the ice while absent on the east. These cylindrical holes containing the gray powdery "cryoconite" (Nordenskiöld) and presumably formed by the heat-absorbing power of the dust are interpreted as indicating excess of wastage over supply.

Other glaciological problems for which Greenland affords a classic field are glacier structure and its relation to movement—a field in which one of our own geologists, Chamberlin, accomplished some noteworthy work. Then there is the iceberg. One-tenth of the wastage of the ice sheet is attributed to loss in this form. Kayser gives an effective description of the "shooting out" of the bergs from the fiords with the spring release.

The existence of the great mass of the inland ice, projecting far south into the region of cyclonic storms has a more than local climatological influence, pronounced as this is. H. Petersen, in his chapter on climate, refers to Greenland as an "obstacle" lying in the way of the Polar Front, a conception which seems to fit in with the actual wind conditions.

Likewise interesting is the hydrographical situation of the country—on its eastern side is the only broad channel of communication between the Arctic and the warm seas. J. N. Nielsen describes the physical characteristics of the waters off the east, south, and west coasts and the fiord waters, illustrating with cross sections showing temperature and salinity. He also has a bathymetric chart of the waters south of the latitude of Smith Sound, "as far as is known the first of its kind." The temperature of the water layers both of fiords and the open sea is of practical interest in relation to the fisheries (see the chapter on fauna by A. S. Jensen). An instance in point is the influence of the high summer temperature of the Great Hellefiske Bank off Holstensborg, far higher than that of more southerly coast banks, and the movement of halibut.

The plant life of Greenland, which has long attracted attention, is described by C. H. Ostenfeld (flora) and E. Warming (vegetation). Among the problems of origin discussed by the former is the question of survival during the Glacial Period. From the distribution of species on nunataks and in the high mountains it is considered probable that the hardiest species survived in the country itself through the maximum glaciation. As regards the origin of higher plants as a whole, of 390 known species 74 are from Europe, including those brought by the early Norse settlers, and 316 are of American origin.

The situation of Greenland at the place where the North American continent most nearly approaches Europe has drawn it into the discussion of possible land connections. In support of his hypothesis Wegener brought forward the supposed westerly drift of Greenland in the last century. M. Vahl, discussing the geographical situation of Greenland, states that the inaccuracy of the old observations for longitude make it impossible to use the results with assurance. A permanent station for determination of position was, however, established east of Godthaab in 1926; and results from it will soon be available.

The total area of ice-free land is estimated at 313,000 square kilometers, of which no large area is now completely unknown. It is thus possible to give some idea of the geology of Greenland as a whole, says O. B. Böggild. He describes the country as a horst of archean rocks with younger formations grouped around it, "distinctly related to those of surrounding countries." Thus Lauge Koch has traced the Caledonian folding of northern Greenland in Grinnell Land; the great basalt outpourings of the center of the east and west coasts are of the same type as those of Iceland and the Faeroes, with which they are connected by a submarine ridge. Interpretation of the past and present land forms, however, meets peculiar difficulties. The narrow coast strip is compared by K. Birket-Smith to the "extreme twigs of a tree, the trunk and main branches of which are hidden from view." True, there is some compensation; and this last-mentioned contributor (on the physiography of West Greenland) points to the exceptional opportunity afforded by the great extent of naked rock for the study of the influence of jointing. He finds that jointing plays a notable rôle in the fiord and valley formation of the west coast and believes that too great weight has been attributed by many observers to faulting in this area. Lauge Koch, who writes on the physiography of northern Greenland, finds no faulting in the great sedimentary plain of this region, but there is pronounced faulting in the Cape York area explored by him on his last northern expedition. On the other hand, E. Storgaard says there is hardly any doubt that the east coast owes its peculiar character to faulting.

A setting for the physical studies of which a brief indication is given above is provided by preliminary chapters on early exploration by Louis Bobé, on cartography by F. H. Trap, and on scientific investigations by C. F. Wandel. As Admiral Wandel points out, our intimate knowledge of Greenland is largely due to the efforts of the

Commission for the Direction of the Geological and Geographical Investigations in Greenland, which began to function in 1877 and has published the results of its work in the well-known series, *Meddelelser om Grønland*. The present work had its inception in the preparations for celebrating the two hundredth anniversary of the landing in Greenland of the Danish missionary Hans Egede on July 3, 1721. A commemorative work in Danish appeared under the title of "Grönland i Tohundredaaret for Hans Egedes Landing" (see review in *Geogr. Rev.*, Vol. 12, 1922, p. 668). It is a systematic account. The English work has a broader appeal. It is to comprise three volumes; Volume 2 will deal with the past and present population, and Volume 3 with the colonization of Greenland and its history.

A final word regarding Volume 1 must have reference to the excellence of its illustrations, maps, and photographs. The three-and-a-half million inhabitants of Denmark may well take pride in their government's encouragement of scientific study.

Greenland at Work and Play

Sophie Petersen. **Grønland: I hverdag og fest.** 186 pp.; maps, ills., bibliogr. C. A. Reitzels Forlag, Copenhagen, 1928. 10 x 7 inches.

Lector Petersen has traveled in Greenland and studied it; she has written textbooks which are translated into the Eskimo language for use in the Greenland schools. She is a geographer and has a wide knowledge of the country in all its various aspects. Above all she is human and gives a most sympathetic description of the Greenland Eskimo, telling us of the history, culture, and life of this small branch of the human race. Her style is easy and direct; in the chapters where she describes her travels we feel as if we were with her and shared her interest and joy in what she sees.

Anyone who wants to know something about Greenland and who understands the Danish language should read this book, which gives an amazing amount of accurate information although written in a semi-popular form. It is nowhere dull and is profusely illustrated with a selection of beautiful photographs which speak a language that everybody can understand.

Miss Petersen concludes by saying: "Greenland is the land of the Eskimos; but in the two hundred years which have passed since Hans Egede landed Denmark has not only explored the country but also colonized and Christianized it. Mistakes may have been made from time to time, but the welfare of the native population has always been kept in view. Under a protective monopoly the Eskimos have been hitherto successfully sheltered against the dangers which have made havoc, for instance, among their kinsmen in Labrador. Denmark, therefore, more than any other nation, has acquired the right to help the people of Greenland also in the future, to safeguard its interests, and to educate it towards independence."

The book ends with a beautiful little poem by Professor William Thalbitzer, the distinguished authority on the Eskimo language and culture.

William Hovgaard

Adaptation versus Assimilation in Africa

R. L. Buell. **The Native Problem in Africa.** Vol. 1, xiii and 1045 pp.; maps. Vol. 2, x and 1101 pp.; maps, bibliogr., index. (Bureau of International Research, Harvard University and Radcliffe College.) The Macmillan Co., New York, 1928. $15.00. 9½ x 6½ inches.

Mr. Buell is an out-and-out opponent of the theory of assimilation, which was the dominating creed of liberal opinion during the nineteenth century. The result of its application in Africa may be studied in the four "Communes de plein exercice" in Senegal and in the position that has arisen in the Union of South Africa out of the grant of the franchise, more than seventy years ago, to the natives of Cape Colony on the same terms as to Europeans. He regards both as unsatisfactory. But the circumstances are different. Senegal was not, like the Cape, a colony of white settlement, and the grant of the franchise to the natives, without requiring them to know French or to conform to French law was not, as Mr. Buell points out, in conformity with the philosophy of assimilation.

At the Cape a large and growing white population found itself in contact with a recently emancipated colored population and also in contact with the Bantu tribes beyond the Fish River. The obviously just way of dealing with this situation appeared to be that which was embodied in Rhodes's famous dictum "equal rights for all civilized men south of the Zambezi." Twenty years ago it would probably have been impossible to find any liberal prepared to oppose this principle, and one of the most remarkable facts in the present situation is that liberals like Mr. Buell are now so united in its condemnation. The reason for this is that the leaven of Western culture works through individuals and not through social organizations. It has been impossible to endow an African tribe as a whole with all that European civilization connotes. Sechele's lament, after he had been converted by Livingstone, still remains true, "In former times, when a chief was fond of hunting, all his people got dogs and became fond of hunting too. If he was fond of dancing or music, all showed a liking to these amusements too. If the chief loved beer they all rejoiced in strong drink. But in this case it is different. I love the word of God, and not one of my brethren will join me." What happens when a tribe comes into contact with European culture is that some individuals assimilate the new ideas more rapidly than others and thereupon tend to break away from their old tribal connections, which become irksome to them. The resulting break-up of native social organizations before an adequate substitute for them has been evolved has led to a strong liberal reaction against the theory of assimilation which encouraged it and to the adoption of the opinion that the first consideration must be the preservation and the reintegration, where necessary, of tribal institutions.

Mr. Buell whole-heartedly joins in this movement. His book is a comprehensive plea for it more than a discussion of the native problem as a whole. He takes it as his standard for judging all European action and claims that it alone can fulfill the requirements of the mandates. The system of indirect rule adopted in British West Africa has his approval, for it has this object in view. The same system is now being introduced into Tanganyika, whose governor has defined it in the following terms, which are quoted by Mr. Buell: "At this stage it is far more important that we should as far as possible build up the authority of the chiefs in order that the people of this country should take a proper place in the political future of Tanganyika than that we should seek a standard of excellence in the native which in the circumstances it is quite unreasonable to expect that we should find."

This policy is naturally more easily applied in those parts of Africa which are unsuited to white settlement, for in them only one standard of progress, the native, need be considered. Even here, however, interference by the European government is often necessary. Mr. Buell recognizes the controversy over the Forest Ordinance in the Gold Coast as a case in point. Attempts to enforce the provisions embodied in this ordinance through the chiefs, that is to say by indirect means, having failed, the government was obliged to pass legislation, doing so directly over their heads. This is the dilemma that faces every African administrator. When should he interfere? When should he abstain? The assimilationists were for continual interference. The new school of abstentionists is for limiting it. But it is unavoidable in both cases, and every time it is applied it weakens the authority of the chiefs.

The problem is infinitely more acute in those parts of Africa where white settlement is already a fact. There the native is pitted not against his own standard but against that of the whites, which is higher. Is this to his disadvantage? Mr. Buell we think too readily assumes that it is. He declares, for example, that the Cape franchise "has not been of material importance to the Cape native and colored people." The natives, however, do not think so, for throughout the Union they are united in their demand that these particular franchise rights should be left to them undisturbed, and in their resistance to General Hertzog's proposal to substitute in their place a form of communal franchise spread over the whole Union. Buell regards the labor which the natives perform for the whites, or "European industrialism" as he calls it, as the principal cause of tribal disintegration. No one can deny the element of truth in this assertion. But it is not the whole truth. Other influences are equally potent. Among them is the one we have already noticed—the individualism which is one of the outcomes of modern progress and with which tribal institutions are hardly compatible.

May the future not prove that those who are now brought into direct contact with European influence, as represented by white settlement, will be better adjusted to it than those who lead a more sheltered and sequestered existence? He would be a bold man who would be dogmatic in framing a prophetic reply to this question. The development of the negroes in the United States since emancipation is some indication of what the African is capable of. Can his brothers in Liberia show anything equal to it? However, these are matters of opinion of which the future alone can judge. Africa is bound to receive an ever increasing amount of public attention. Its problems are among the most baffling that the world can produce. They must be studied from every point of view, and Mr. Buell has laid us all under a great obligation by collecting together such a vast mass of material all of which is essential to a proper understanding of them.

H. A. WYNDHAM

THE ATLAS OF EGYPT

Atlas of Egypt: A Series of Maps and Diagrams With A Descriptive Text Illustrating the Orography, Geology, Meteorology, and Economic Conditions. Presented to the International Geographical Congress at Cambridge 1928 by Command of His Majesty King Fouad I. 11 pp. of text; 31 pls. Survey of Egypt, Giza, 1928. 28 x 33½ inches.

This atlas, compiled, drawn, and printed in Egypt as that country's contribution to the International Geographical Congress in Cambridge last year, is a delightful piece of workmanship. To H. Sirry Bey, Surveyor-General of Egypt, who was in charge since 1927, and to all the others who had a part in it the greatest credit is due.

The general and orographical maps by Dr. John Ball reflect the vastly increased knowledge of the desert gained in the last fifteen years, largely by the use of motor mechanical transport. The general map (scale 1:2,000,000) does not show the old camel routes but only the tracks along which more or less regular motor communications are maintained and the routes of the chief recent exploratory expeditions by motor car. The latter include the important series executed from 1923 to 1926 by Prince Kemal el-Din Hussein (compare reports on these expeditions in *Bull. l'Inst. d'Égypte*, Vol. 7, 1924–1925, pp. 53–61, and *Comptes Rendus de l'Acad. des Sci.* [*de Paris*], Vol. 183, 1926, p. 935, *La Géographie*, Vol. 5, 1928, pp. 171–183).

Perhaps the two most striking of the new features shown on the map are the Gebel Owenat massif made known by Hassanein Bey in 1923 and the Qattara Depression, 137 meters below sea level at its lowest point, whose existence was only proved in 1926 although it lies so near the Mediterranean (compare the article by Sirry Bey elsewhere in this *Review*). The orographic map (1:1,000,000), while generally following the millionth scheme, departs from it in one notable respect. The all-important distinction in Egypt is between desert and arable land; hence green is reserved for the arable land, all the desert land above sea level being in brown tints, that below sea level in gray. The geological maps, by W. F. Hume and his successor in the

Geological Survey, O. H. Little, show only a relatively small area on the west left blank: specially striking is the detail mapping in the Sinai Peninsula. The meteorological section, by L. J. Sutton, maps the usual meteorological elements for an area as far south as the Central African lakes. A novel feature is the introduction of six maps of recognized weather types. Diagrams of relative humidity show that in the northern Sudan in April-May humidity is practically zero.

The population-density map (1:500,000) is extraordinarily effective. The desert is in pale buff; inhabited Egypt in seven tints of gray-blue, showing population gradations of from less than 100 (by isarithmal lines, to use the term proposed in Eckert's "Kartenwissenschaft," Vol. 2, p. 189) per square kilometer to over 1000 per square kilometer. The population-density map exhibits close agreement with that of value of agricultural raw material. According to Mr. J. I. Craig, Controller-General of the Census, who furnishes the letter press for the economic maps and diagrams (compiled by Mr. F. S. Richards), an increase of £2 Egyptian a year in the annual value of crops for a given area roughly corresponds with an increase of 1 inhabitant on the same area. There is a general economic map and a map of the density of cotton cultivation, in which it appears that the maximum area devoted to cotton is in the middle delta. Diagrams of crop areas and cultivated land bring out graphically the fact that considerable parts are cropped twice a year.

An Atlas of Estonian Agriculture

Eesti põllumajandus: Statistiline album (Agriculture en Estonie: Album statistique). 112 pp.; maps, diagrs., ills. Bureau Central de Statistique de l'Estonie, Tallinn, 1928. 14½ x 10½ inches.

Whenever delightful publications of this type emanate from such small countries as Estonia, only three-sevenths the area of Ohio and having but one-sixth of its population, one's admiration for that country is profoundly stirred. True, Estonia is a nation, while Ohio and other states are but parts of a nation; but equally true is the fact that the wealth of our states should enable them not only to provide atlases of their respective areas but to provide atlases of merit.

The Estonian volume, printed in both the national language and in French, incorporates an idea rarely found in technical atlases, namely photographs illustrative, in part, of the subject matter treated in the maps and charts. Much interest is thereby added to the publication. The text likewise in close proximity to the maps illuminates the atlas and aids the reader in his interpretations. This volume is the third and last in a series descriptive of the life of Estonia, the first dealing with territory and population, the second with economy.

Every aspect of the country's agriculture is presented in minute detail, including such phases as the commerce of agricultural commodities (including forest products), the status of agricultural workers, landownership, and educational progress.

The choice of colors throughout reflects something of the colors in favor among the people. They reveal numerous striking contrasts, some harmonious and others not so but on the whole pleasing. Bar charts, pie diagrams, curves, block-shaded maps, picture diagrams, and other devices are utilized effectively to show a vast array of data. There are so many facts of interest that to attempt even a few citations would hardly do justice to the volume. Estonians may rightly take pride in an instructive atlas well done.

Eugene Van Cleef

Agriculture in Finland

E. Cajander. **Geographische Übersicht des Landbaus in Finnland.** 92 pp.; maps, diagr., bibliogr. *Fennia*, Vol. 47, 1927, No. 14. Helsingfors.

In a country where the major part of the population is engaged in agricultural pursuits a detailed study of agricultural limitations acquires significance. Cajander has devoted a number of years to a careful investigation of crop distribution in Finland and in this publication presents maps and charts delineating his findings and interpreting them in a clear-cut discussion. It is the more interesting because of its intensive treatment of a small area in which virtually every stage of agriculture from primitive to modern is represented and in which climatic cross sections reveal a range from intermediate to arctic and from modified marine to continental.

Among the maps particularly worth noting is one representing the dates of the beginning of spring cultivation and the ending of fall cultivation, followed by another indicating the total number of days in the cultivation season. These maps are in contrast with the traditional length-of-growing-season maps to which geographers have long been accustomed. In his interpretation Cajander sets the date for spring as the time when the average daily temperature reaches 5° C. and the fall date when the temperature of 0° C. is reached. He remarks, however, that these dates may be offset by rains which might retard the beginning of spring cultivation and move forward the fall date, in some years affecting both dates and in other years only one. On the whole, however, the cultivation season thus noted is usually longer than the growing season. The spring date of the working season varies as one might anticipate between southern and northern Finland.

Another map differing from the usual reveals a "Weideperiode," that is a season during which cattle may pasture in the meadows without adversely affecting their milk production and without injury to their health. The beginning of this period is set at the time when the daily average temperature reaches 8° C. and ends in the fall when it reaches an average of 5° C. Attention is directed to a distinction between this period and that of the meadow or grass period itself, the latter being longer than the former.

Climatic crop zones are established on the basis of the climatic characteristics of respective regions and the dominance of certain crops. Another agricultural division of the country is viewed from a regional standpoint based largely upon a combination of topography, soils, and character of crops. The country has been divided into twelve regions, admittedly not all perfect units but nevertheless offering in general a convenient treatment in the light of present development. A résumé of this regional discussion also appears in *Erde und Wirtschaft*, Vol. 2, 1928, pp. 45-64.

A full bibliography gives opportunity for further study of the agricultural situation.

EUGENE VAN CLEEF

A GEOGRAPHY OF WISCONSIN AGRICULTURE

W. H. EBLING. **Wisconsin Agriculture: A Statistical Atlas, 1926-1927.** 102 pp.; maps, diagrs., ills., index. *U. S. Dept. of Agric. and Wis. Dept. of Agric. Crop Reporting Service Bull. 90.* Madison, 1928. 11½ x 8¼ inches.

This so-called statistical atlas might well have borne the title "A Geography of Wisconsin Agriculture." It includes twenty-odd dot maps and smaller but more numerous cartograms of the kind ordinarily used to show distributional phenomena. On the former the dots are localized by township from data supplied by local crop reporters who communicate their observations and estimates regularly to the Wisconsin Crop and Livestock Reporting Service. There are certain to be inaccuracies in data accumulated in this manner, but this is also true of the census returns. In the cartograms the disks (solid circles), which are localized by counties, give a less accurate picture of distribution, but the geographic sectionalism is obvious.

The scheme generally followed is a dot map showing the distribution and the acreage of a single crop such as corn. A circle diagram gives the world situation in corn for the year 1926, and a cartogram of the United States gives the corn acreage by states. These three graphic devices and the comparative statistical tables are accompanied by a brief text explaining and interpreting the data and graphs. To these are added two or three maps for critical times in the past, thus picturing the history of agricultural development. In this manner all of the important crops and animal industries are treated briefly. A series of bar diagrams shows the changes in the acreage of the principal crops from year to year.

Of social interest are the cartograms showing the percentage of farm homes having daily newspapers, telephones, radio sets, automobiles, motor trucks, milking machines, running water in kitchen or in the barn, bathtubs, pianos, children taking music lessons, and similar items indicating rural standards. It is interesting that there is considerable discrepancy in the figures on running water in the kitchen and in the barn. For example, 50 per cent of the farms of Fond du Lac County have running water in the barn, but only 16 per cent have it in the kitchen. In Vernon County, however, the figures are 17 and 22 per cent respectively. In Rusk County only one per cent of the farm homes have bathtubs, but in Sheboygan County the proportion is 20 per cent. In general, the southern or southeastern portion of the state shows up more favorably than the "pioneer belt" of northern Wisconsin.

GUY-HAROLD SMITH

SOIL MAPS OF THE WORLD AND ITS PARTS

PAUL KRISCHE. **Bodenkarten und andere kartographische Darstellungen der Faktoren der landwirtschaftlichen Produktion verschiedener Länder.** 111 pp.; maps, diagrs., ill. Paul Parey, Berlin, 1928. 24 Rm. 13 x 9½ inches.

The struggle to produce food products during the war, the existing agricultural depression, the rapid development of the new science of pedology, and the awakened interest in supplies of natural resources, a logical development of intensive industrialization throughout the world, have all contributed their part to an awakened interest in the soil as a natural body worthy of study in and for itself and as the most important natural resource any nation can have. Interest in the distribution and characteristics of soils throughout the world has recently become very great.

Dr. Paul Krische, editor of "Die Ernahrung der Pflanze," an illustrated bimonthly journal published by the German Kalisyndikat, has performed an important service to pedologists, students of agriculture, economists, and teachers in bringing together in one publication the existing cartographic data on the soils of the world. In addition to this he has included a great deal of information on the other factors of agricultural production such for example as climate, along with agricultural production data expressed in graphic as well as cartographic form, such as acreage of land in agricultural use, total yield, total production by countries, production and relative yield of the main agricultural crops by countries.

The first and last maps are soil maps of the world, the first being the old map by Glinka published more than a decade ago, and the last, the new map by Prassolov, published in 1927. The first is followed by probably the most striking map in the collection showing the proportional area of each of the subdivisions of the world now in agricultural use as well as the area used in the production of what Krische calls the main agricultural crops, wheat, rye, oats, barley, maize, rice, potatoes, and sugar plants.

The charts and maps are accompanied by a text in which the general features of the great soil groups are described, including the important features of their profile and a discussion of their relation to the geographic environment.

The third section, including the main part of the work, covers soil maps and cartographs and the presentation of other features of agricultural production of various countries. Charts are introduced which bring out strikingly the contrast between the "Agricultural Great Powers," the "Middle Powers," and the rest, in acreages, total production, and yield per unit area. This is followed by the soil maps proper with rather full discussion of their features.

One fact stands out very clearly on an examination of the work. Very few of the soil maps meet the requirements of pedology in its existing stage of development. Too many of them are mere texture maps showing light, medium, and heavy soils. These are important in agricultural practice undoubtedly, but they do not constitute the most important soil facts, even considering the latter from the agricultural rather than the scientific point of view. Soil science is of such recent development that it has not yet expressed itself in the form of good maps. Krische has done important service in showing that the existing soil maps, while important from many points of view, constitute merely a beginning of what a complete cartographic representation of the soils of the world demands.

C. F. Marbut

The Seaports of Texas

Max Hannemann. **Die Seehäfen von Texas, ihre geographischen Grundlagen, ihre Entwicklung und Bedeutung,** *Frankfurter Geographische Hefte*, 1928, No. 1, Frankfurt am Main, 1928.

Texans may well be surprised to learn that "Texas even now is often regarded as a backward country, which, to be sure, produces cotton but whose significance in world trade is not particularly great. . . ." And yet Dr. Hannemann cites statistics showing that 14.1 per cent of the export trade of the United States, by value, in 1924 and 1.2 per cent of the international trade of the world in 1924 passed through the harbors of Texas.

In this volume, clearly arranged and containing much useful information, we see the ports of Texas through the eyes of a European scholar who spent fourteen months on the ground in 1924–1925. The first part gives a general description of the physiography and climate, as well as of historic and economic conditions as a background for a detailed description of the individual seaports which follows. The author devotes his attention more particularly to the eastern portion of Texas. The growth of the ports has been governed essentially by the economic development of this region, he holds. "The number and the bulk" of the products of states other than Texas exported from the Texan harbors are so limited that these ports "would not suffer any serious injury if the shipment through them of goods from outside of Texas were to cease." On these grounds Dr. Hannemann feels warranted in confining his view to Texas. Another reason for doing so was the difficulty encountered in establishing definite boundaries of the hinterland tributary to the Texan harbors. "To mark off such limits," Hannemann complains, "would require long-protracted studies of the details of North American trade statistics not available to me." If such studies had been made, the American reader would not, perhaps, experience an uncomfortable feeling that the author has occasionally forgotten that Texas is part of the United States.

Dr. Hannemann points out that until about 1900 little work had been done toward the improvement of the Texan harbors. Galveston, on its barrier beach, exposed to wind-blown floods during tropical hurricanes, "was the only harbor of any great significance." During the last three decades the exploitation of the oil fields of Texas has been accompanied by phenomenal economic growth and a movement of the centers of shipping to such river ports as Houston, which has now outstripped Galveston in maritime commerce. Freight rates from the interior to the river ports are not as high as to Galveston, and the river ports are less exposed to floods. Extensive artificial improvements, however, have been necessary: the deepening of channels, the digging of canals, and the construction of docks and other terminal facilities.

Cotton cultivation in the British Empire through its effect on the European market for Texas cotton, the exhaustion of the timber lands in Texas, and the inevitable ultimate cessation of petroleum exports "whether the result of the depletion of the oil wells or of competition with artificial substitutes"—these circumstances make it probable that the Texan harbors are approaching a climax in their growth. On the other hand, Dr. Hannemann is confident that the continued commercial prosperity of the coastal belt of Texas as a whole, if not of every individual harbor, is assured, since this belt is destined to serve as the seaward outlet not merely of Texas "but of a large and as yet little-developed region in the interior of the continent."

Problems of the Great Lakes

R. E. Horton and C. E. Grunsky. **Hydrology of the Great Lakes.** xvii and 432 pp.; maps, diagrs., index. (Rept. Engineering Board of Review of the Sanitary District of Chicago on the Lake Lowering Controversy and a Program of Remedial Measures, Part III, Appendix II.) Sanitary District of Chicago, 1927.

Readers of Mr. Philip W. Henry's paper on "The Great Lakes-St. Lawrence Waterway" in the April, 1927, number of the *Geographical Review* (Vol. 17, pp. 258–277) will be interested in this volume, presenting in detail data upon which the results discussed in that article are based. It is one of the series of reports inspired by the suit of six northern states asking in view of the lowering of the Great Lakes water level for an injunction against the city of Chicago for the withdrawal annually from Lake Michigan of 8500 cubic feet per second of water. This diversion reversed the flow of the Chicago River, opened a navigable waterway to the Mississippi River, yielded a solution to the city's sewerage problem, and furnished a modicum of water power—altogether benefits of great value but benefits which cause losses and nuisances to others.

The report analyzes the various causes of lake-level lowering and estimates the part each has played in the result. The tilting of the land surface which has been operative since glacial times may be neglected as a factor. Deforestation has had a different effect in the different lakes, but for the Michigan-Huron surface it is found that the cutting of timber has been beneficial to the water level. The depression of four feet in the Michigan level on the basis of the level of 1885 is assigned thus—diversion of waters is responsible for 6 inches, channel improvement for 8 inches, and deficient rainfall for 36 inches. In the face of this loss, compensating works and regulating works are necessary to raise the level as much as possible even though there can be no compensation for the deficient rainfall. For this reason the courts decided to withhold from Chicago the water which the city has been using for sewerage wash.

This report is an interesting and usable presentation, giving easy access by index to the more elaborate arguments and the tabulated data and well illustrated by maps and graphs. It might well serve as a type for reports carrying of necessity a large array of statistics.

Robert M. Brown

Dr. Nansen on Some Geophysical Problems

Fridtjof Nansen. **The Earth's Crust, Its Surface-Forms, and Isostatic Adjustment.** 121 pp.; diagrs., ills., bibliogr. *Avhandlinger utgitt av det Norske Videnskaps-Akademi i Oslo: I, Mat.-Naturv. Klasse,* 1927, No. 12.

In 1922 Dr. Nansen published an attractive volume entitled "The Strandflat and Isostasy." The *strandflat* is a coastal platform adjacent to Norway and other northern lands. Its nearly even surface, developed on hard rocks, lies near sea level and has a maximum width of 40 or 50 kilometers. Nansen thinks this surface was developed in part by subaerial agents and in part by marine planation, before and perhaps during the Pleistocene glaciation; that portions of the surface were depressed by the weight of the ice; and that all parts have come back very nearly to the original level. From his study of this remarkable physiographic feature he concludes "that isostasy is the normal state of the earth's crust, and that the continental crust has at all times and in all regions had a tendency to readjust its isostasy after disturbances and, in the course of time, to approach its isostatic level at least within some few meters in height."

Evidently this special investigation has led Nansen to a more general study of geophysical problems, and his latest volume is the result. The first part is devoted largely to theoretical problems. He conceives that the granitic crust formed by solidification of the light superficial layer of a molten globe was rafted together to make separate continental masses, much as the floes in the polar seas are made by the breaking up and telescoping of the ice. These relatively light masses are buoyed up above the denser ocean floors, and isostatic adjustment is maintained as erosion progresses. From several considerations Nansen decides that the average thickness of the continental crust must be between 30 and 50 kilometers. He analyzes arguments advanced by Jeffreys and Holmes for a smaller thickness, and advances good reasons for adopting the higher figures. The level at which plastic flow for isostatic adjustment can occur is well below the continental crust, probably at a depth of 60 kilometers or more.

The operation of isostatic adjustment is considered in connection with evidence from the Pleistocene ice sheets, particularly in Fenno-Scandia. Nansen shows the great complexity of the problem. Relations between land and sea during the melting of the ice were conditioned by (1) the immediate elastic recovery of the crust on relief of load, (2) the rise in sea level on return of the water from the melting glaciers, (3) decrease of the gravitational attraction on the sea of the diminishing caps, (4) slow rise of the land as subcrustal flow restored isostatic balance, (5) gravitative attraction of the ocean water by the rising land. At times the factors whose effects were opposed may have exactly balanced each other. So long as the land was rising continuously with relation to sea level there would be no opportunity for formation of any well marked strand line. Development of such a feature would require that land and sea rise at exactly the same rate for a considerable time. Nansen thinks, therefore, that the highest strand line visible in Scandinavia does not give a full measure of postglacial uplift. Probably the ice sheet at the center was more than 2000 meters thick, and the crust became completely adjusted to this load before the last retreat began. Recovery has been almost complete, but the slow upward movement still in progress may eventually carry the central area 20 meters higher.

Discussion of the glacial evidence includes a brief summary of facts and conclusions regarding the strandflat. Nansen's exposition of this subject is able and interesting; but the reviewer cannot accept some of his conclusions without reservation. The meaning of the strandflat appears still to be a debatable matter. Exactly how and when was this remarkable feature formed? To what extent was it depressed or deformed by the weight of the ice cap? Nansen attempted to answer these questions in his book on the strandflat; but it does not appear that he was entirely satisfied with the results, inasmuch as he offers revised conclusions in his latest work. Evidently the strandflat is worthy of further study.

The most valuable part of this latest book, to American readers, is the discussion of the Scandinavian strand lines and their bearing on postglacial history. It seems unfortunate that suitable maps and other figures were not introduced to make this treatment more understandable. In the reviewer's opinion, the book would have gained by further expansion of this subject and omission of the somewhat rambling discussion devoted to broad speculative questions in the closing pages. The orderly reasoning and the quantitative checks used in earlier chapters are less evident in the discussion of mountains and geosynclines. Nansen rejects the hypothesis of mountain folding by contraction of the globe, on the ground that it is not consistent with the limitation of world-wide folding to certain periods in geologic history, separated by long intervals of comparative quiet. He then ascribes the major crustal deformations to isostatic adjustments in response to shifting of surface loads through secular erosion. Surely this mechanism cannot be expected to bring about any systematic distribution of orogeny in time or space; and it seems woefully inadequate to produce the known mountain structures. Turning to geosynclines Nansen accepts, as a sufficient explanation of enormous sedimentary accumulations in shallow troughs, James Hall's original suggestion of continued subsidence under the weight of the sediments. The most elementary calculations serve to discredit this theory of geosynclinal sinking, as numerous writers have pointed out. Nansen also makes a fundamental error in his discussion of Joly's fusion hypothesis. Assuming that the granitic continental masses are buoyed up by the denser material in a basic substratum, Joly reasons that fusion of the entire substratum would decrease its density and therefore cause the continents to sink lower into the immersing medium. Nansen insists, however, that fusion would increase the volume of the substratum, thereby lifting the overlying crust. The error in his reasoning is obvious. Increase in volume would of course accompany decrease in density, the floating masses would be immersed more deeply, and the displaced fluid would be forced up through fractures in the crust. Granting Joly's fundamental postulates, this consequence is inescapable. Wooden blocks sink deeper into water than into mercury.

Aside from these obvious weaknesses the book deserves favorable comment. The discussion of geophysical problems is able and stimulating. In the breadth of his interests and training Nansen truly is a remarkable man. It is not strange that a writer so versatile should expose himself to criticism in special fields. In general his scientific papers are sound and valuable.

Chester R. Longwell

Vulcanology

Karl Sapper. **Vulkankunde.** viii and 424 pp.; maps, diagrs., ills., indexes. J. Engelhorn, Stuttgart, 1927. Rm. 36.50. 9 x 6 inches.

Those familiar with Sapper's "In den Vulkangebieten Mittelamerikas und Westindien" (1905) will welcome this more general treatise. It is the result of forty years' study of the subject, during which time he traveled extensively in volcanic regions making observations and collecting information. He tells us that the principal purpose of the book is to lay before the reader the clearest possible pictures of volcanic processes and the topographic forms resulting from them. Many excellent half-tones bring these forms graphically before the eye. A special weight is given to the most complete available accounts of the authentic activity of individual volcanoes. Besides the numerous descriptions of volcanic activity throughout the book, an immense amount of information is condensed in the list of active volcanoes, giving, so far as possible, the dates of each individual outburst, its character and extent. A system of abbreviations keeps the text within bounds. The list and the maps show the geographical distribution of active volcanoes.

Sapper confines himself to the geographical aspects of volcanoes; he refers to Wolff's "Vulkanismus" for the geological side of the subject. With the exception of the chapter by the late Professor Bergeat, the petrography of volcanoes is disregarded.

The general plan of the book is a classified description of the volcanic processes, all illustrated by and referred to special volcanoes and volcanic regions. There are accounts of fumaroles and solfataras; explosive, effusive, and mixed volcanoes; the topographic forms built up and the changes due to erosion; the peculiarities of individual regions and individual volcanoes; the frequencies and periodicities of outbursts, etc. The final chapter gives a short history of the conceptions of volcanoes from the earliest times to the present.

Sapper accepts the results of American observers, who found a large amount of water vapor in the gas emanations of volcanoes, in contradiction to Brun, who concluded that water vapor is very scarce in many cases. He inclines to Day's ideas of volcanic processes, but shrinks from the idea that neighboring volcanoes are independent, and cites some experiments of Lowthian Green, from which the latter deduced the possibility of the great difference of level between the lava of Mauna Loa and Kilauea, even though derived from the same magmatic mass. Green made many valuable observations on the Hawaiian volcanoes, but unfortunately his dynamical conceptions were not sound.

HARRY FIELDING REID

THE LEHRBUCH DER METEOROLOGIE CONDENSED

REINHARD SÜRING. **Leitfaden der Meteorologie nach Hann-Sürings Lehrbuch der Meteorologie.** xii and 426 pp.; maps, diagrs., ills., index. C. H. Tauchnitz, Leipzig, 1927. M. 18.50. 10 x 7½ inches.

For a good many years there has been a wish on the part of meteorologists for a condensed and shortened form of Hann's famous "Lehrbuch der Meteorologie" (the latest edition, thoroughly revised by Süring, appeared in 1926. See review in *Geogr. Rev.*, Vol. 16, 1926, pp. 685-686), costing less and somewhat better suited to the needs of the majority of students who wish to gain a general idea of our present knowledge of atmospheric phenomena and principles but who have not the time or the need for a detailed study. Hann himself was fully in sympathy with this desire on the part of his younger fellow workers and asked his colleague, Süring, to prepare such a shortened form of the "Lehrbuch." This has now been done.

In the "Leitfaden" we have a volume which will really fill a gap in meteorological literature. The guiding principles in preparing this new volume were (1) the preparation of the most condensed possible discussion of subjects which have been adequately considered in recent published investigations; (2) emphasis upon the physical rather than upon the geographical aspects of meteorology, although the latter have by no means been neglected except in so far as they are purely climatological; (3) inclusion of complete bibliographical references. The general arrangement of the material is the same as that in the fourth edition of the "Lehrbuch." The sixth section, dealing with mathematical and physical problems, has been largely rewritten. Following the general plan of the "Lehrbuch," there is only very brief discussion of weather forecasting, theoretical meteorology, instruments, and optical phenomena. It was Hann's own view that there was no need of including these subjects, because of the fact that they have all been adequately discussed in special publications devoted to them.

We feel sure that the "Leitfaden der Meteorologie" will prove a very useful and helpful book to those who have been somewhat staggered by the size and price of the "Lehrbuch."

R. DEC. WARD

EXPLORATIONS AND HUNTING IN THE ALASKAN AND SIBERIAN ARCTIC

MRS. JOHN BORDEN. **The Cruise of the "Northern Light":** xi and 317 pp.; end map, ills., bibliogr. The Macmillan Co., New York, 1928. $4.50. 9 x 6 inches.

In 1927 Captain John Borden, a trustee of the Field Museum of Natural History, Chicago, conducted a hunting and natural history expedition to the Aleutian Peninsula and the Arctic Ocean north of Bering Strait. The party on the *Northern Light* included, besides Mrs. Borden, the authoress of this book, three ladies, all keen sportswomen with a taste for adventure and the courage to undergo whatever hardships or dangers it might involve. The expedition left San Francisco in April and, after securing several Kodiak brown bears near Pavlof Bay, turned northward towards the polar ice pack in search of white bear and walrus. The party enjoyed excellent hunting of both animals between the Siberian coast and Wrangel Island and experienced without mishap all the thrills of navigation in the dangerous ice pack. Captain Borden made some new soundings here, finding 25 fathoms of water at the position of the hypothetical "Borden Island" reported some fourteen years ago by the survivors of the *Karluk*. He then skirted the coast of Wrangel Island and anchored for a few hours off Rogers Harbour in full view of the newly established Russian colony. The colonists acknowledged his salute by hoisting the Soviet flag, but either through fear or because they possessed no boat they made no attempt to communicate with his vessel; and Captain Borden refrained from landing. The expedition then sailed south, calling, among other places, at Bogoslof Island, which had just been convulsed by a new eruption.

Mrs. Borden narrates simply and with much charm the numerous adventures and misadventures of the expedition. She gives interesting details of the bird and plant life they encountered and vivid descriptions of the outlying settlements at which they called—the fishing communities at Unga and King Cove, the sealing colony in the Pribilofs, the Eskimo villages at King Island and at Point Hope, and the Chukchi village at Cape Serdze Kamen.

D. JENNESS

A STUDY IN POPULATION MIGRATION

ARTHUR REDFORD. **Labour Migration in England, 1800-50.** xvi and 174 pp.; maps, index. (Publs. Univ. of Manchester, Econ. Hist. Ser. No. 3.) The University Press, Manchester; Longmans, Green & Co., Ltd., London, New York, &c., 1926. 15 s. 8½ x 5½ inches.

This book naturally divides itself into three sections. The first is a detailed study of the shiftings of population in England and Wales consequent upon the industrial developments of the first half of the nineteenth century. The second is a review of the movement from Ireland to England which was motivated, in part at least, by the same conditions. The third is a consideration of the outward movement overseas in its special relation to the internal currents.

The redistribution of the industrial population of England and Wales most concerns the author. His treatment of it abounds in such a multiplicity of place names, dates, and other details as to make it difficult for one not wholly familiar with English geography to visualize the broad outlines of the phenomena. Fortunately, the author himself supplies the desired generalizations in a lucid closing chapter. In general, the industrial redistribution represented a series of inward, concentric movements. Each of the growing industrial towns drew toward itself representatives of the surrounding populations, in numbers almost exactly inversely proportional to their distance from the center. There was relatively little long-distance movement even after the coming of the railroad.

The section dealing with the Irish immigration is probably of the greatest interest to the average American, displaying a striking resemblance on a small scale to the characteristic oversea immigration to the United States. The effects upon wages, unemployment, standards of living, and social attitudes are almost identical with those observed on this side of the Atlantic. There were Irish "birds of passage" to England just as there have been Italian sojourners of the same type in the United States.

A generalization, of interest to any student of migration, is confirmed by this study. Whenever a country of higher economic levels is accessible to the individual workers of a country of lower economic levels there will be (in the absence of restraint) a movement of population from the latter to the former, to the observable detriment of the former. Up to the present time, because of ignorance of the principles involved, most efforts to promote or arbitrarily direct migration movements have been either futile or pernicious.

Henry Pratt Fairchild

The Swedish Topographical Survey

Svenska Lantmäteriet 1628–1928: Historisk skildring utgiven av Sällskapet förutgivande av Lantmäteriets Historia (Swedish Topographic Survey. Historic Description Edited by the Society for Publishing the History of the Swedish Topographic Survey). Vol. 1, viii and 629 pp.; maps, diagrs., ills.; Vol. 2, 614 pp.; map, ills.; Vol. 3, 41 maps. P. A. Norstedt & Söner, Stockholm, 1928. 11½ x 8½ inches.

The above impressive volumes are issued to commemorate the tercentenary of the Swedish Topographic Survey as a governmental institution and its thorough reorganization in 1908–1920. They treat the different phases and activities of the Topographic Survey during the past three hundred years in eighteen independent articles, among which may be mentioned: Organization of the Topographic Survey, Development of Surveyors, Technique of Surveying, and Cartography of the Topographic Survey. Several papers deal with legal and economical problems, land divisions, etc.

The maps in Volume 3 aim to give an idea of the different types of maps at different times.

Ernst Antevs

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OUR CONTRIBUTORS

Sir Hubert Wilkins' first polar experience was gained with Stefansson from 1913 to 1916 on the Canadian Arctic Expedition. He was in the Antarctic from 1920 to 1921 and again from 1921 to 1922, on the latter occasion as naturalist on Shackleton's last expedition. Then followed (1923–1925) the Wilkins Australia and Islands Expedition for the British Museum (Natural History). The three seasons' work in the Arctic (1926–1928) culminated in the flight from Alaska to Spitsbergen.

Dr. Mill's geographical work has been largely directed towards discovery of "the control exerted by the various forms of the earth's solid crust upon the fluid envelopes." It is exemplified in the maps and reports for "British Rainfall," of which organization he was for many years director. Dr. Mill has filled various offices in the Royal Meteorological Society and in the Royal Geographical Society and has been a member of the International Council for the Study of the Sea. His contributions to educational geography include "The Realm of Nature," "Hints on the Choice of Geographical Books," "The International Geography," which he edited; while he has given us a classic in "The Siege of the South Pole."

Major Isachsen is one of the directors of the Geographical Society of Norway and the director of the Maritime Museum at Oslo. He has spent many years in the Arctic: as topographer on Captain Sverdrup's *Fram* expedition 1898–1902 to the Northern Arctic Archipelago; 1906–1910 and 1920–1921 in Spitsbergen; 1922 in Iceland and the Faeroes; 1923 and 1924 in Eastern Greenland. He visited Antarctic waters 1926–1927 to complete an intensive study of the whaling industry.

Dr. Dainelli is professor of geology and physical geography at the University of Florence. He has carried out field investigations in Italy's African colonies and, as a member of De Filippi's expedition of 1913–1914, in the Himalaya, Karakorum, and Chinese Turkestan. In addition to reports on these expeditions he is the author of an interesting monograph "La distribuzione della popolazione in Toscana" (*Memorie Geogr., No. 33,* 1917) and he has made a special study of Dalmatia.

Miss Semple has written extensively on the influence of geographic environment on man. Her "Influences of Geographic Environment" (1911) is a standard exposition of the subject in English. Her "American History and Its Geographic Conditions" (1903) is also widely known. She has made a special study of the geography of the Mediterranean in classical times. Miss Semple has contributed several papers to the *Geographical Review* and its predecessor, the *Bulletin of the American Geographical Society.*

Dr. Bryan is assistant professor in the Department of Geology and Geography at Harvard University. He specializes in physiography of arid regions and of the water problems of the arid west. With E. C. La Rue he contributed "Persistence of Features in an Arid Landscape: the Navajo Twins, Utah" to the *Geographical Review* (April, 1927).

Mr. Marmer has for many years been connected with the Division of Tides and Currents of the U. S. Coast and Geodetic Survey and is now serving as Assistant Chief of the Division. To the *Geographical Review* he has contributed several papers and to "Problems of Polar Research" (*Amer. Geogr. Soc. Spec. Publ. No. 7,* 1928) the chapter on Arctic Tides. He is the author of "The Tide" (1926).

Mr. Wright is librarian of the American Geographical Society and is in charge of the Society's New England studies.

Dr. Jones is professor of geography in the University of Chicago. He has carried out field studies in northern Patagonia (as a member of the survey conducted by Professor Bailey Willis, 1911–1913), in China and Japan (1916), and in India (1920). To the *Geographical Review* he contributed "Hokkaido, The Northland of Japan" (Vol. 11, 1921). He is co-author with D. S. Whittlesey of "An Introduction to Economic Geography" (1925).

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THE
GEOGRAPHICAL REVIEW

VOL. XIX JULY, 1929 No. 3

THE WILKINS-HEARST ANTARCTIC EXPEDITION, 1928–1929

Captain Sir Hubert Wilkins

[With separate map, Pl. IV, facing p. 374]

MY first visit to the Antarctic was made in 1920. In that year I went south to Deception Island and there came to know the sterling qualities of the captains and managers of the Norwegian whaling companies. The original aim of the expedition to which I was attached[1] was to survey the King Edward VII Land area and reach the south pole by airplane. We had a vessel almost completely fitted and twelve airplanes—a gift from the Royal Air Force Disposal Board, old war-time stock which we intended to use in relays, abandoning more than half of them en route. However, the hoped-for support failed, and the main objective of the expedition had to be abandoned. We changed our plans and decided to try to reach the Graham Land plateau and with dog teams journey as far south as possible. The airplanes were returned to the air force, and finally a party of four with a twenty-eight-foot lifeboat, seven dogs, two sled boats of special design, and ample food and equipment for two years were landed, through the courtesy of the Norwegian whalers, at a small island in Andvord Bay on the western shore of Graham Land (lat. 64° 48′ S.). It was evident from observations made in De Gerlache Strait that our dogs would be worthless. From a distance we could see the level top of Graham Land faced with sheer precipitous cliffs several hundred feet high. Our only hope was to carry the dogs and our supplies on our backs to the plateau and then make a quick dash southwards—a forlorn hope and one never realized. We maintained our base on a little penguin-covered island. With our lifeboat we traveled several hundred miles

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[1] This was the British Imperial Antarctic Expedition under J. L. Cope as leader.

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up and down the coast, surveying about thirty miles of new coast line. It was obvious that aircraft would be necessary to carry out a survey of Graham Land; and the expedition was disbanded, though two members decided to stay over the winter season.[2]

I came back to New York and managed to persuade the agent for the Junker monoplane to put two machines at my disposal for Antarctic exploration. The plan for 1921-1922 was to accompany the Norwegian whalers to Port Lockroy, near Antwerp Island, and from there make flights in seaplanes as far as possible with the machines available. The provisos attached to the gift, however, threatened the possibility of delay beyond the time for connecting with the whalers at Montevideo in September. At this time Sir Ernest Shackleton was making preparations for his Antarctic expedition in the *Quest*. He opened negotiations and finally persuaded me to postpone my plan and join him on his expedition, during which we might fly not only at Graham Land but at other points along the Antarctic coast line. The *Quest* car-

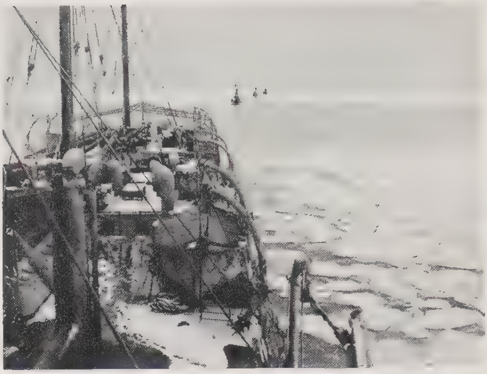

Fig. 1

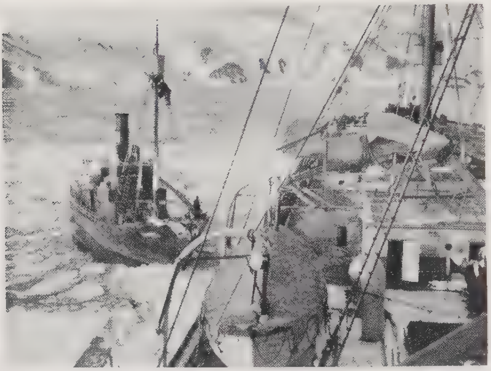

Fig. 2

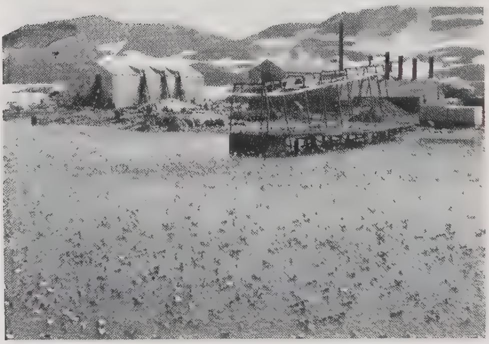

Fig. 3

Fig. 1—The *Hektoria* with the small whale catchers in Bransfield Strait. (All photographs illustrating this article are copyright by the *New York American* and Universal Service.)

Fig. 2—Thin and scattered ice in Deception Harbor.

Fig. 3—The bird life, which practically covered the harbor, was a serious menace to the seaplanes.

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[2] M. C. Lester: An Expedition to Graham Land, 1920-1922, *Geogr. Journ.*, Vol. 62, 1923, pp. 174-194.

ried our airplane part of the way, but with other of our polar stores it was left at the Cape Town depot. A series of delays prevented us from collecting the machine before we went into Antarctic waters. Our experience throughout the three months (January–March, 1922) in the Antarctic served to confirm my belief that airplanes could be used successfully throughout an Antarctic summer.

THE EXPEDITION REACHES ITS BASE

On my return from the Point Barrow-Spitsbergen flight in the spring of 1928 I began preparations for the Wilkins-Hearst Antarctic Expedition. The American Geographical Society sponsored the enterprise. The many acknowledgments due for support of the expedition are made in the appendix to this report. The main equipment comprised the Lockheed Vega monoplane used on the Arctic flight and a duplicate machine. Our staff consisted of Lieutenant Carl Ben Eielson, my companion and pilot on many flights, Pilot Joe Crosson of Alaskan fame, and Engineer Orval Porter, who had accompanied me to the Arctic in 1926. We left

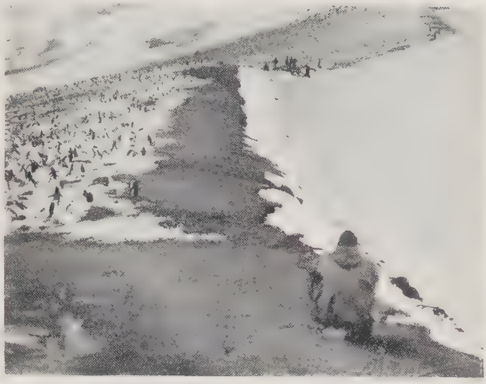

FIG. 4

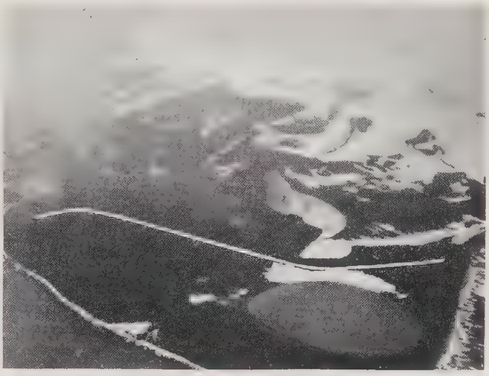

FIG. 5

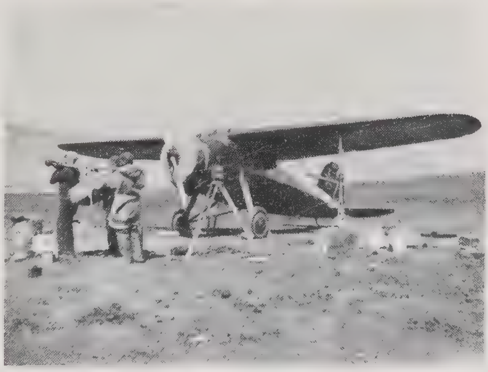

FIG. 6

FIG. 4—A penguin rookery on the steep slopes of Deception Island.

FIG. 5—The landing field on Deception Island (compare Fig. 7). The runway is indicated here and on Figure 38 by a white line.

FIG. 6—The Lockheed Vega monoplane *San Francisco*, in which our long flights were made.

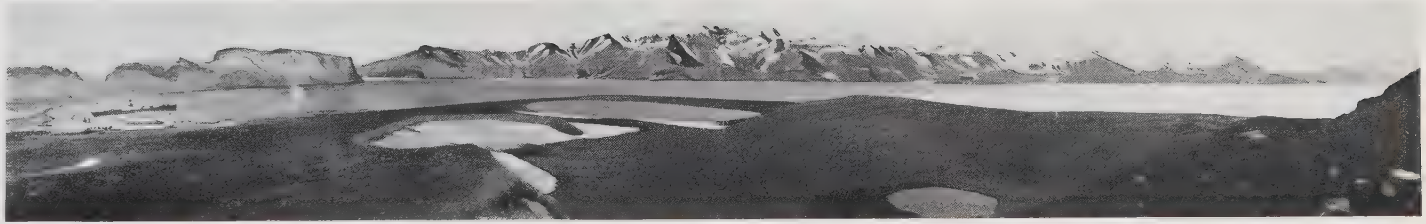

FIG. 7—Panorama of the landing field and Deception Harbor.

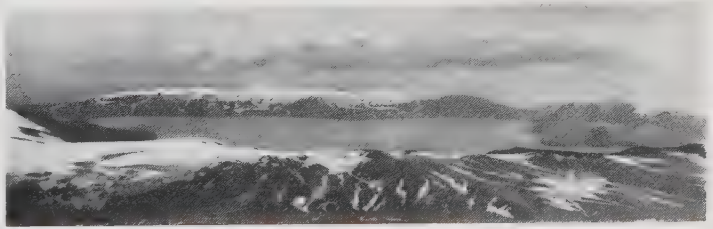

FIG. 8—The landlocked harbor of Deception Island.

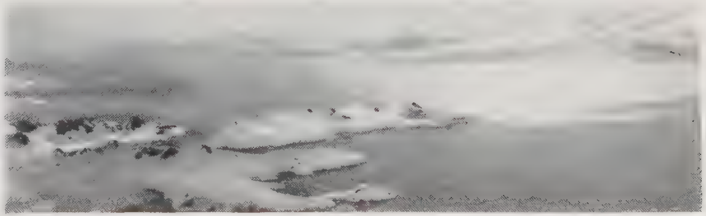

FIG. 9—Bransfield Strait, Graham Land, and Brabant Island.

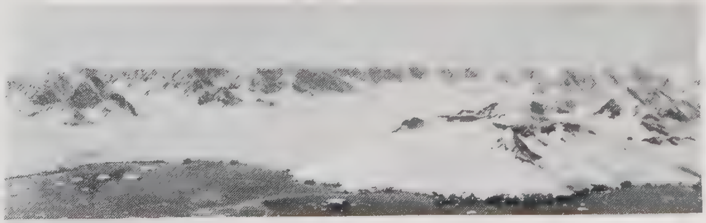

FIG. 10—Brialmont Bay, northern Graham Land. (For location see B, Fig. 39.)

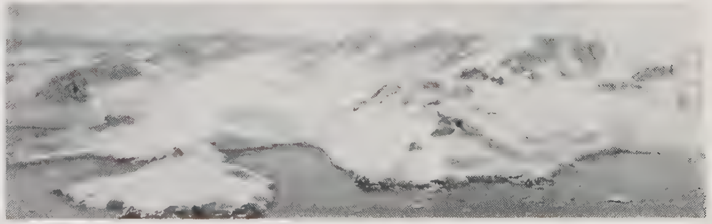

FIG. 11—Salvesen Bay, northern Graham Land. (For location see C, Fig. 39.)

New York on September 22 and made a comfortable and uneventful journey to Montevideo, at which place I obtained the services of Victor Olsen, radio operator. At Montevideo our two planes, set up in flying order, and the other paraphernalia were loaded on board the *Hektoria*, a ship of 15,000 tons register. We were most comfortably accommodated. Our journey to the Falkland Islands was uneventful. At that place I received from His Majesty's Government authority to claim new lands and territories for the British Empire.

Soon after leaving the Falkland Islands we met with snowstorms, high winds and rough seas, and, as we approached the ice, with fog. The small catchers went out ahead to act as a vanguard. Our course took us between King George Island and Elephant Island, and as we entered Bransfield Strait we met with scattered ice and an occasional berg. Bransfield Strait was loosely filled with ice, but it offered no barrier to our progress. We entered Deception on November 6 to find the ice thin and scattered and the land but lightly covered with winter snow. In fact much of the land was bare, and whalers who had visited Deception Island every year for the last fourteen years proclaimed it to be an unusual season. The *Hektoria* was moored stern to the beach with her decks but a few yards from the shore. A gangplank was run out from the land, and we had free access to and from the boat. On November 10 we unloaded the seaplane that Eielson and I had used on our Arctic flight. It made further history as the first complete airplane to touch Antarctic soil: Sir Douglas Mawson, it may be noted, had landed an airplane fuselage minus wings at Adelie Land in 1913.

Trial Flights

While Deception Harbor in the vicinity of the ship and shore station was free from ice when we arrived, the bay, seven miles deep and five miles across, was in November covered with smooth flat ice. Records show that for fourteen years this bay ice remained firm and solid until about Christmas Day. As a rule it is about six or seven feet thick when the whalers arrive, and it was upon the dependableness of this ice that I had based my scheme of operations. I planned to use skis, make a flight to reconnoiter Weddell Sea, select a more southerly base, and then when conditions were favorable take the two planes, alight some five or six hundred miles south of Deception, and with one plane reloaded fly on along the coast to the Ross Sea Barrier. It was believed that the period between the fifteenth and the twentieth of December would be the best for this work. The second machine would of course return to Deception Island. We examined the flat bay ice and much to our consternation found it not more than two feet thick. The mildness of the season or the warmth from the volcanically influenced beaches surrounding it had melted the ice at its edges and honeycombed it in the center. A violent storm might possibly break it up at any moment. Obviously it was unsafe to leave our machine unattended upon its surface.

The small amount of snow on the flat-surfaced land was fast disappearing. There seemed to be one place from which we could fly the machines with skis from the land to the bay ice when the weather was fine, and from the sea ice we hoped to take off for our preliminary flights. Accordingly we fitted skis to our planes and waited upon the weather. Extraordinary weather came but not of the kind hoped for! Rain and high temperatures continued for several days, and the snow disappeared. Water six to eight inches deep formed on the flat ice in the harbor. We were compelled to change our skis for wheels, and we cleared a short runway on a hillside where the volcanic tuff and lava were fairly level.

Cloudy weather prevailed, but on November 16 we essayed the first flight ever made in the Antarctic and looked down through the clouds upon the runway we had built across the small peninsula on the western side of the whalers' anchorage.

No longer flight, however, could be attempted until November 26, when our two machines went in opposite directions seeking a better field from which to make a start. We flew over the landlocked harbor at Deception Island. The neighboring islands except two, Low and Snow, were high and mountainous. The low-lying ones were covered with deep snow, badly crevassed. On the others, including Livingston Island, the mountains rose to 6000 feet almost sheer from the sea. We flew for several hours about the cloud-engirdled mountains; then, as the midnight sun was sinking to its lowest level, we followed the shadowed coast to our base.

We had not found a place elsewhere that would serve our purpose, and so we carefully tested the bay ice at Deception and decided one cold clear morning to risk a landing on it. This nearly brought disaster. The machine landed safely but ran far beyond the three-hundred-yard area we had tested into a soft patch in the ice and fell through. The wings and fuselage held it from disappearing beneath the water. Eielson, who was piloting, climbed out unhurt; and with the help of twenty whalers and after several hours of difficult and extremely dangerous work we managed to raise the machine and drag it to a safe place on the ice. Next day we attached the pontoons and brought the machine back to the beaching place near the ship and factory.

The machine was none the worse for its wetting, and we made many tests of it as a seaplane, always with the hazard of the sea birds in the harbor. Birds were attracted in millions by the activities of the whaling factory on the shore. Pilot Crosson, who has had much experience with seaplanes and who carried out these flights, showed

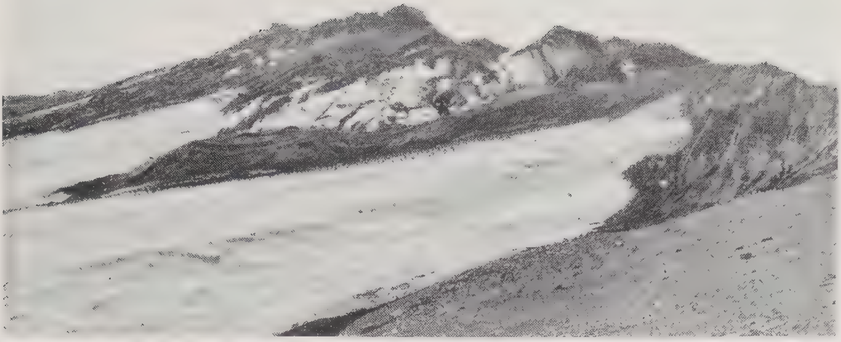

FIG. 12

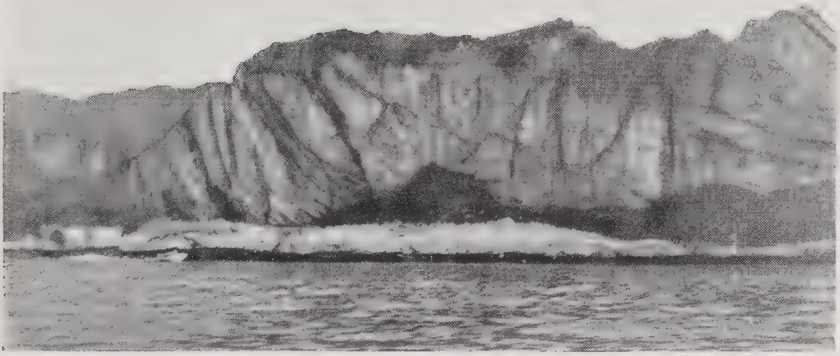

FIG. 13

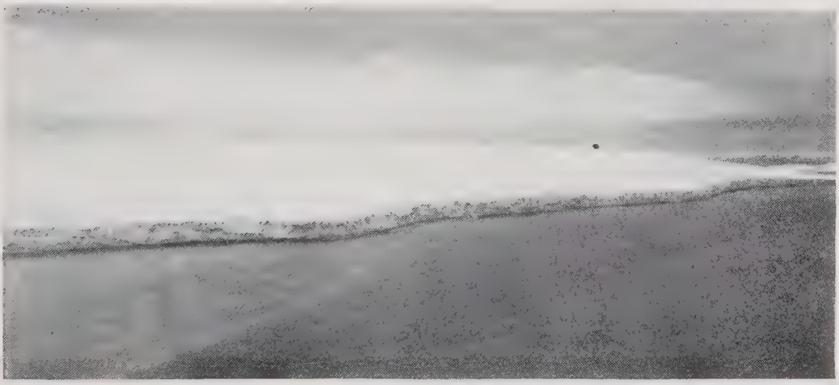

FIG. 14

FIG. 12—The glacier on Mt. Pond, Deception Island: the only glacier on the island which "truly merits the name."

FIG. 13—Banded ice and ashes of the Mt. Pond glacier on Deception Island.

FIG. 14—Snow Island, low-lying and covered with deep, crevassed snow.

much courage and skill. Although we struck and killed several birds our machine was never out of control nor badly damaged. It soon became evident, however, that our only chance of doing anything from Deception Island that season lay in using the machines as land planes. It would be necessary to extend the runway on the land and go south on wheels. To make a runway half a mile long—the distance across the peninsula—through the mounds of lava that resembled piles of large-sized coke, looked at first like an impossibility. With courage born of necessity we started the job and with hands, wheelbarrows, buckets, rakes, and shovels, cleared many tons of débris and had at last a runway forty feet wide and about two thousand five hundred feet long. It had two bends in it of about twenty degrees, and the surface was soft and cindery.

A forced landing anywhere throughout the journey would mean disaster. The greatest danger, however, lay in the take-off; the greatest difficulty for the pilot was to handle the heavily laden machine on the soft-surfaced runway. But something worse threatened. The weather could not be depended upon after December. Hence, relying on Eielson's ability to control the machine and providing as far as possible for any emergency, we loaded two hundred gallons of gasoline into the tanks, filled our packs with our spare clothes, equipment, and food consisting of biscuits, pemmican, chocolate, nuts, raisins, and malted milk sufficient for thirty days on a twelve-ounce-per-day diet. There was ample room for our packs and alpine climbing gear in the cabin of the plane. Each man's equipment was separate and intact. It could be seized and swung upon our backs at a moment's notice or discarded with equal facility. In case of accident and a forced march home we should each have our own supply if one or the other happened to go through a crevasse. To each man's alpine rope was attached a pole and a small strong block and tackle with which he could, if uninjured, haul himself up the rope in a vertical position.

OVER NORTHERN GRAHAM LAND

On the morning of December 20 the weather was perfect, just a little wind, a clear sky, and sparkling atmosphere. The thermometer on the ground stood at about 38° F., a tolerable temperature except when we were working in our warm Worumba clothes: then we were uncomfortably warm.

At 8.20 a. m. we were in the air heading south. The hazardous take-off had been, with Eielson's skill and courage, successfully accomplished. We directed our course a little west of south, taking the peak of Trinity Island as a landmark. Once in the air our machine functioned perfectly, the engine seeming faultless. Even though we were climbing, our ground speed averaged more than 125 miles

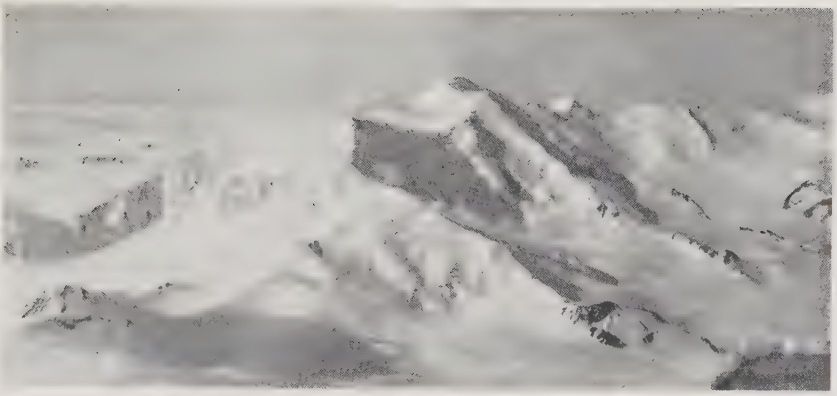

FIG. 15

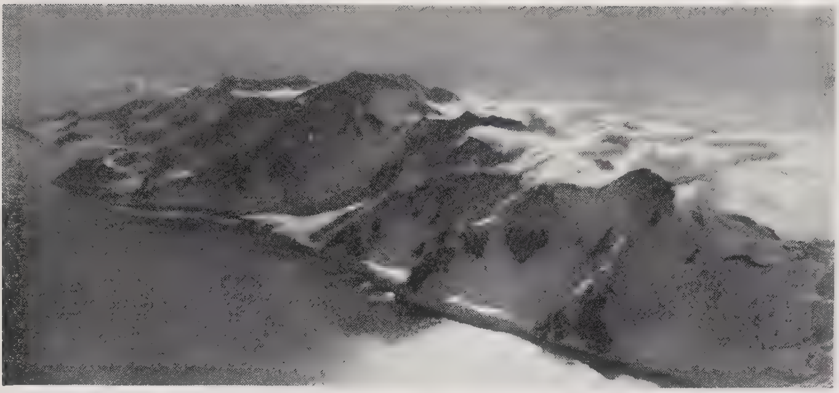

FIG. 16

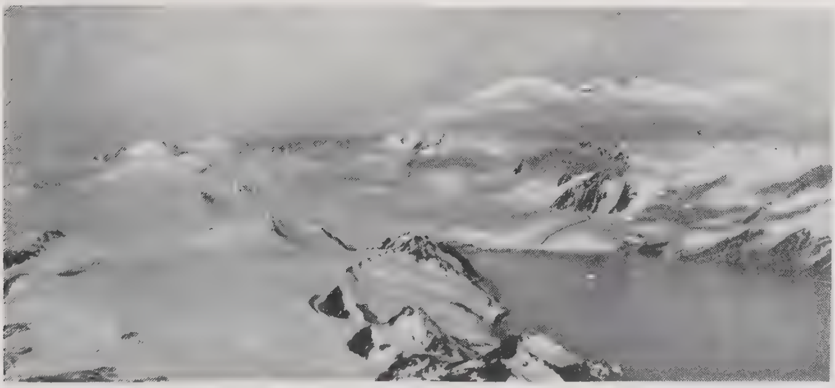

FIG. 17

FIGS. 15, 16, 17—Livingston Island as seen during our preliminary flights in search of a better landing field than that afforded by Deception Island. This mountainous ice-clad island, however, offers no possibilities to the aviator.

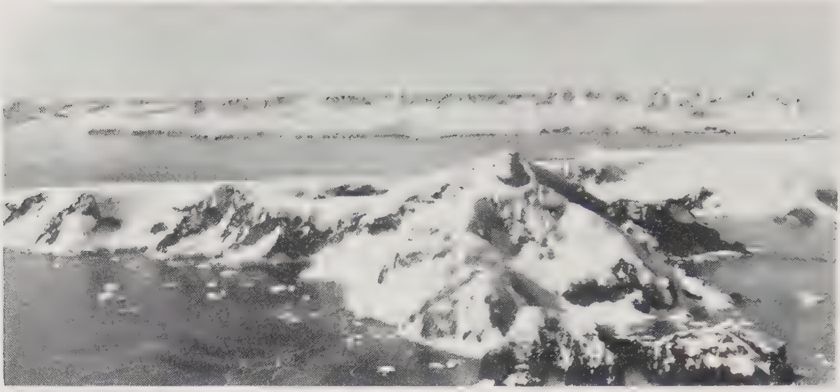

FIG. 18

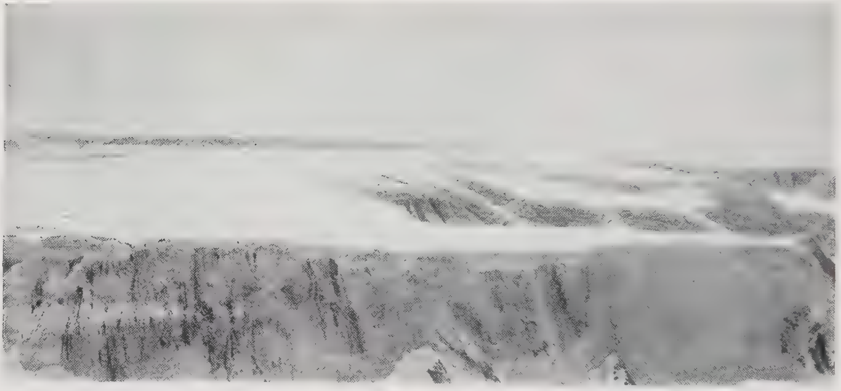

FIG. 19

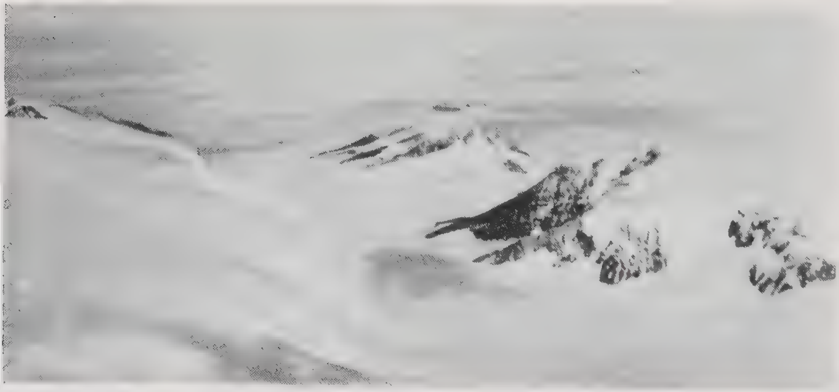

FIG. 20

FIG. 18—Trinity Island, showing table-topped Graham Land in the distance. (For location see A, Fig. 39.)

FIG. 19—Detroit Aviation Society Plateau. (For location see D, Fig. 39.)

FIG. 20—The east coast of Graham Land showing the Seal Nunataks in the distance. (For location see E, Fig. 39.)

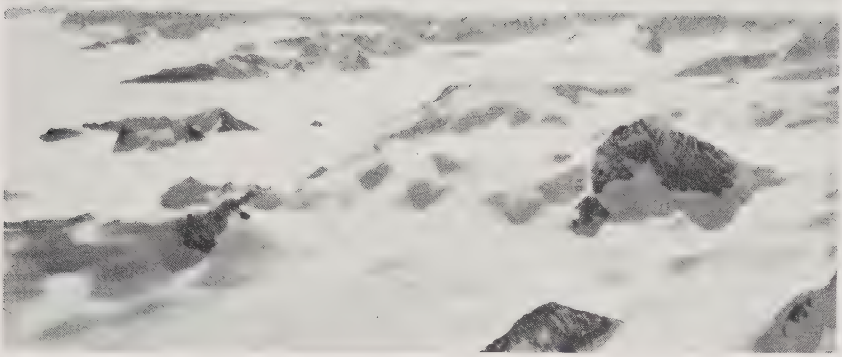

FIG. 21

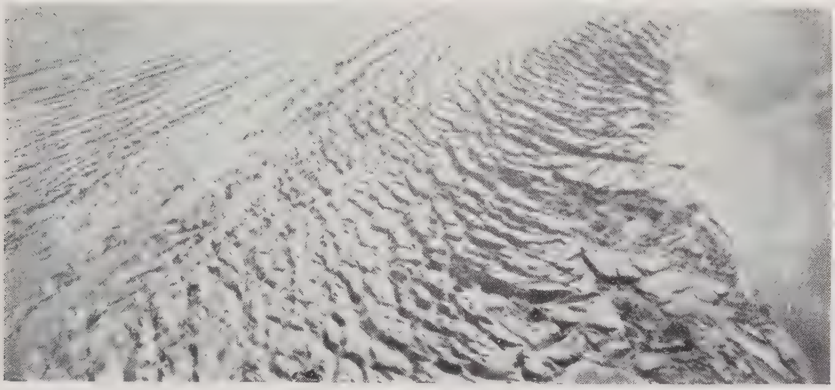

FIG. 22

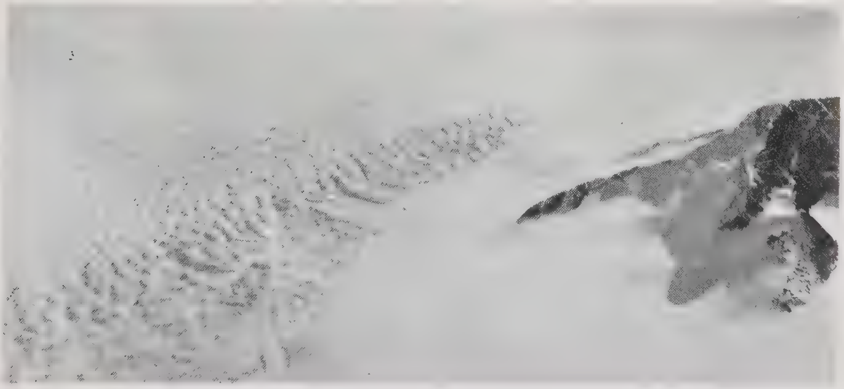

FIG. 23

FIG. 21—Hektoria Fiords, long ice-filled fiords almost severing Graham Land. (For location see F, Fig. 39.)

FIGS. 22 and 23—Crevasses on the Nordenskjöld Shelf Ice in the neighborhood of Drygalski Bay. (For location of Fig. 23 see G, Fig. 39.)

per hour. By 8.40 we were at 6000 feet altitude and beside Trinity Island. The plateau of Graham Land, which we could see beyond the island, was marked on our charts "from four to six thousand feet" altitude. At 6000 feet we were beneath its level, so we swerved westward while climbing. We passed Brialmont Bay. At Salvesen Bay, a few miles farther south, we turned and at 8200 feet decided to cross the plateau which we named Detroit Aviation Society Plateau.[3] As far as we could see to the eastward the Graham Land plateau continued. We were above it at 9.50, and for a few minutes we flew due south. To the east we could see the Seal Nunataks and Robertson Island.

Far away to the southeast we could see "water sky" but not much of it, nor was it very distinct. To the west were long ice-filled fiords almost severing Graham Land. These, named Hektoria Fiords, were not photographed until we were on our homeward journey. They are entered from the indentation named Drygalski Bay by Nordenskjöld. We were now flying above ice in Weddell Sea, the Nordenskjöld Shelf Ice. The surface beneath us was broken by huge crevasses into which our machine could have fallen and left no trace. These crevasses, "broad, bottomless, yawning, blue abysses" as Nordenskjöld has described them,[4] were numerous only near the land. At 10 a.m. I noted in my diary: "There appears to be a haze or a very low cloud ahead [we were flying at 8000 feet], or perhaps it is wind which over the Arctic pack ice I know from experience is indicated by milk-white sky upon the horizon." Later an entry reads: "Four hours out. Just struck the first bumpy air experienced today." We had come to the wind we had seen some hours before.

At ten o'clock we were opposite a deep inlet, Evans Inlet, which appeared at first to cut right through Graham Land. In fact I actually made a note to that effect in my log but corrected it later when we could see the mountains at the end of the level ice. Opposite Jason Land was a deep indentation which also threatened to sever the north of Graham Land but which again did not reach quite through. This apparently is Nordenskjöld's Richthofen Valley.[5] The north side of the inlet we called Cape Fritsche, and the south side Cape McCarroll. From there the land trended southwestward in a series of rugged mountains.

On our way south we passed between C. A. Larsen's "Foyn Land" and the coast and saw two conspicuous black mountains which we

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[3] We named the various places discovered with the view of recommending that a committee of geographers, to be appointed by the American Geographical Society, approve of them. See appendix.

[4] Otto Nordenskjöld and J. G. Andersson: Antarctica, or Two Years Amongst the Ice of the South Pole, London and New York, 1905, p. 221. See also references to fissure zones on pp. 226 and 228. See also the description of the Shelf Ice in the scientific results: Otto Nordenskjöld: Die Expedition und ihre geographische Tätigheit (Wissenschaftliche Ergebnisse der Schwedischen Südpolar Expedition 1901–1903, Vol. 1, No. 1), Stockholm, 1920, pp. 158–168.

[5] Nordenskjöld and Andersson, Antarctica, p. 225.

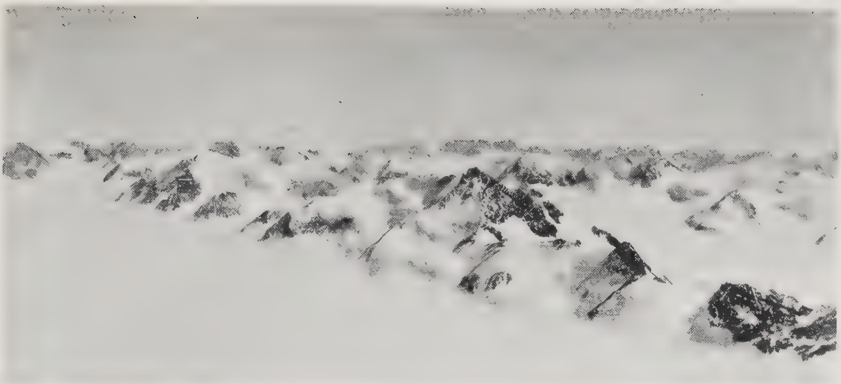

FIG. 24

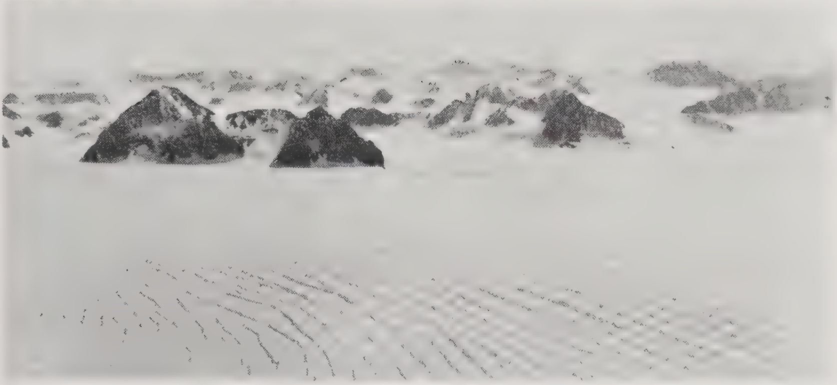

FIG. 25

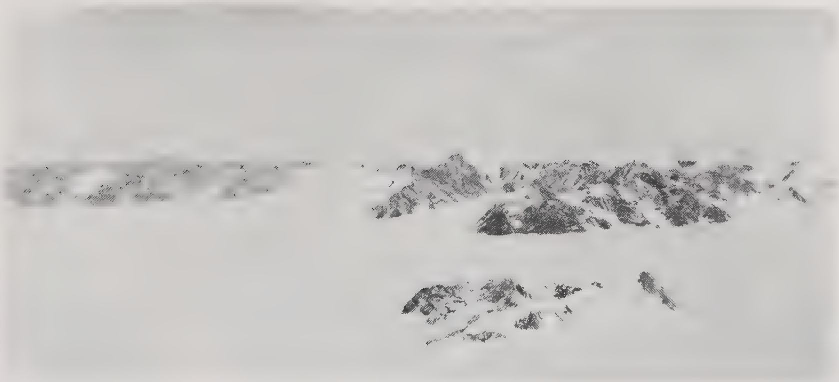

FIG. 26

FIG. 24—Looking from Cape McCarroll toward the end of northern Graham Land. (For location see H, Fig. 39.)

FIG. 25—Mt. Napier Birks. (For location see I, Fig. 39.)

FIG. 26—Crane Channel and Foyn Island. (For location see J, Fig. 39.)

named Mt. Napier Birks. Just south of there we saw what we believe to be a circuitous channel dividing Graham Land. It was not photographed until our homeward journey and when we were outside Foyn Island. It was named Crane Channel.

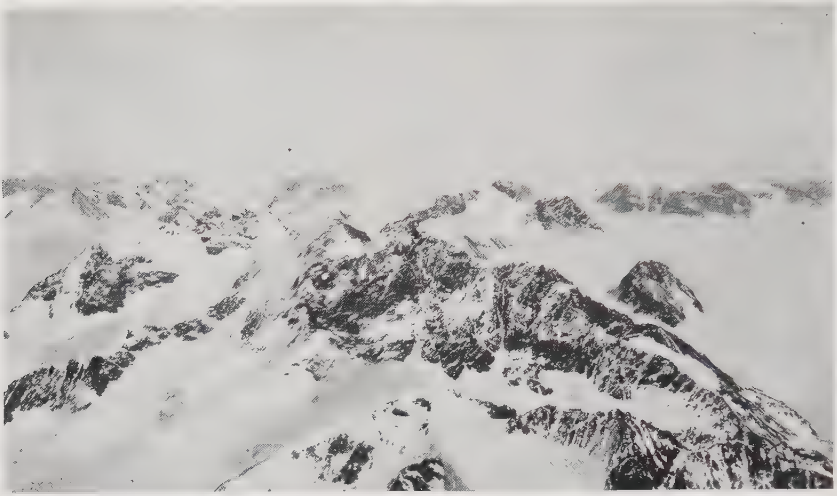

FIG. 27—Lockheed Mountains near Cape Northrop. (For location see K, Fig. 39.)

OVER SOUTH GRAHAM LAND

South of Crane Channel we came near to the coast. I noted in my log that some of the peaks were of stratified material. The entry reads: "The islands have cliffs at their southern sides. The steepest exposures on the mountains face south. The strata in some instances dip north at 45°. There are some black seams showing; perhaps they are coal. Notice three seams here one above the other about a hundred feet apart." That was about latitude 67°. A mighty mass of mountains stretched far to the southwestward from Crane Channel, and opposite was an island not marked on the chart until we named it Robinson Island. The most easterly point of the large island, which we concluded was South Graham Land, we called Cape Northrop; and the mountains we named Lockheed Mountains. From there a bay, Mobiloil Bay, extended deeply towards the west. In the middle of it was a sharp indentation. When crossing it we felt, for the first time that day, a disturbance in the atmosphere. The mountains flanking the northern half of the bay were deeply scarred with four huge glaciers, which we named Whirlwind Glaciers. The coast, which lies farther south than Nordenskjöld or Larsen had been and is opposite Fallières Coast, we named Bowman Coast. In the middle of the bay away from the land the shelf ice looked smooth as a billiard table, but as we approached the coast again at the southern end of the bay the ice became so badly broken that it would be impossible, I believe, to walk across it. On the way back we saw indications of low islands. By 12.32 we were opposite high steep mountains, one of which we named Mt. Ranck, and these seemed to terminate the second part of Graham Land. A channel, which narrowed in its center but appeared to hold only level ice, widened again; and we felt sure that the ice in the channel rests on land below sea level. We named it Casey Channel, and the island south of it Scripps Island.

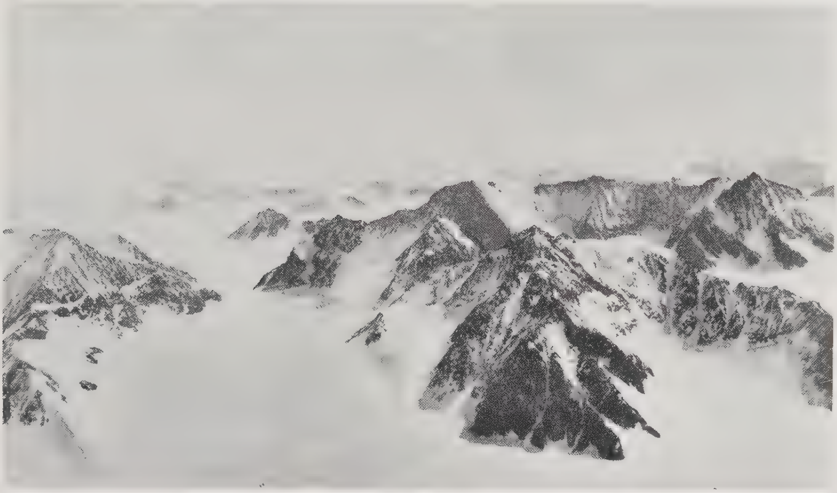

FIG. 28—Cape Mayo (left), Casey Channel, Mt. Ranck, and Cape Keeler. (For location see M, Fig. 39.)

STEFANSSON STRAIT AND HEARST LAND

South of South Graham Land the mountains are not generally as precipitous as on the more northerly islands. Scripps Island is about thirty miles wide. At 12.50 I noted in my log "We are now quite certain that Graham Land is not connected with the mainland continent." We felt sure of this before, but at this point it could be distinctly shown in a photograph. We named the cape at the northern side of that channel Cape Walcott, the channel Lurabee Channel, and the islands to the south the Finley Islands. In a few minutes we could see that the group of islands did not extend very far. They were divided by level, smooth ice. There appeared to be a group of six or more of these islands scattered in a wide strait. We could not clearly define their outlines because we were then flying at two thousand feet, to which height we had descended for observation of the snow surface. Beyond the islands extended a level strait; and farther south a smooth slope, wide and unbroken, reached southward. It was not marked by

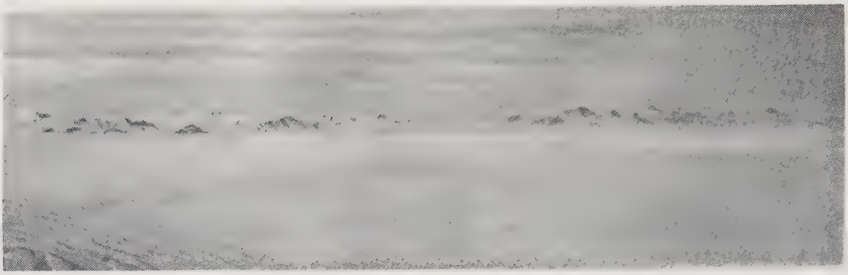

FIG. 29

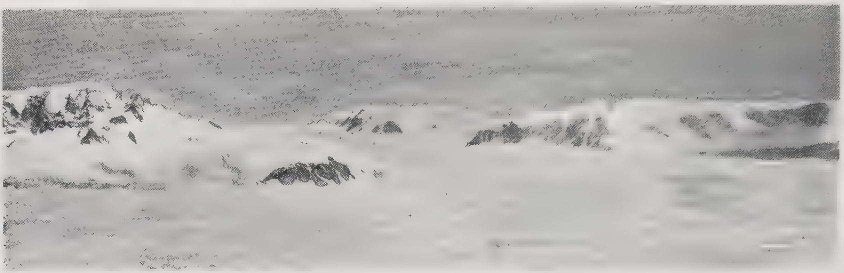

FIG. 30

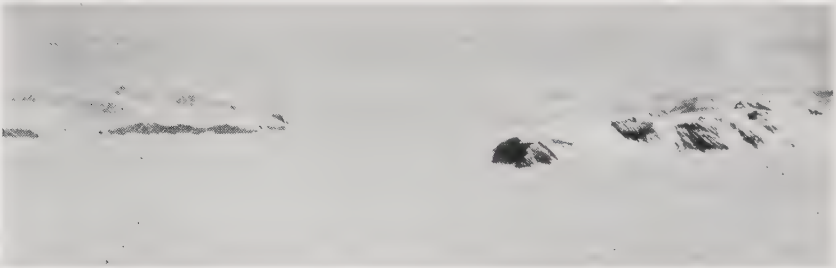

FIG. 31

FIG. 29—Mobiloil Bay and Bowman Coast. (For location see L, Fig. 39.)

FIG. 30—Lurabee Channel between Cape Walcott, Scripps Island (right), and the Finley Islands. (For location see N, Fig. 39.)

FIG. 31—The Finley Islands looking toward Lurabee Channel and Scripps Island. (For location see O, Fig. 39.)

even a speck or shadow and would not show on a photograph. We called the strait Stefansson Strait, and the land beyond it Hearst Land.

The edge of Hearst Land, which we believe to be part of the great Antarctic continent, was distinguishable to the eye by a comparatively low ice cliff, which, because of the angle of the sun, failed to show distinctly in the photograph. And unfortunately at this important point I had difficulty with the camera. To the eastward the edge of the mainland was marked with a few small, low nunataks about a cape which I called Cape Eielson; and from there the low ice cliff swung slightly southward. Far beyond to the eastward, in the dim

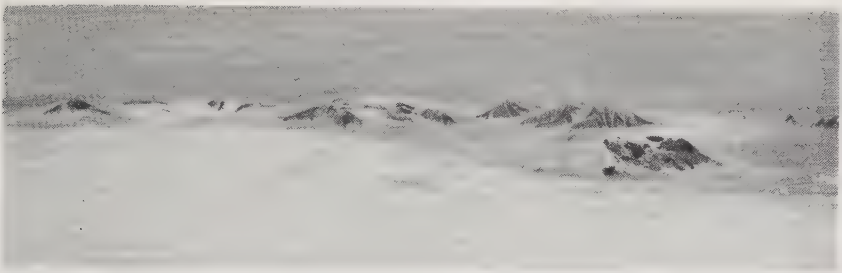

FIG. 32

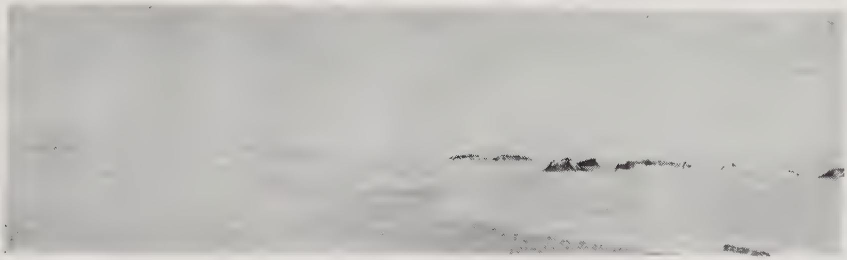

FIG. 33

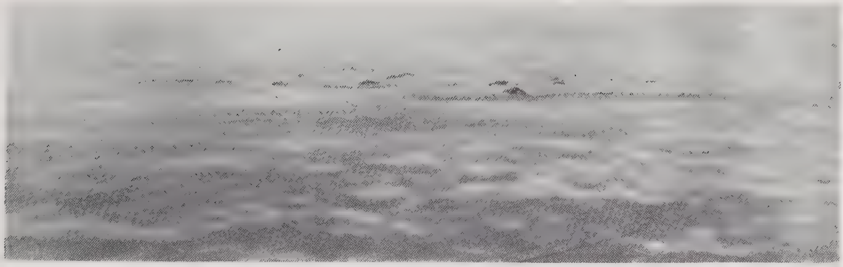

FIG. 34

FIG. 32—The Finley Islands and Stefansson Strait. (For location see P, Fig. 39.)
FIG. 33—Stefansson Strait and Hearst Land. (For location see Q, Fig. 39.)
FIG. 34—Looking northeast over Hearst Land from about lat. 70° 45′ S., long. 64° W. The edge of the mainland is marked by a few small nunataks (Cape Eielson) and a low ice cliff. (For location see R, Fig. 39.)

distance, too far to show on a photograph, I could see huge tabular icebergs standing up above the level of the surrounding ice and concluded that they must have been at one time or were even then afloat.

When we reached a point estimated to be about latitude 71° 20′ S., longitude 64° 15′ W., we had used nearly half our supply of gasoline. We had ascertained that we might land with skis almost anywhere in that vicinity and had proved to our satisfaction that Graham Land was not part of the continental area. Storm clouds that we had seen developing behind us threatened to cut us off from our base; and so with the idea of returning safely with the information gathered we swung our airplane to face the north and hurried homewards.

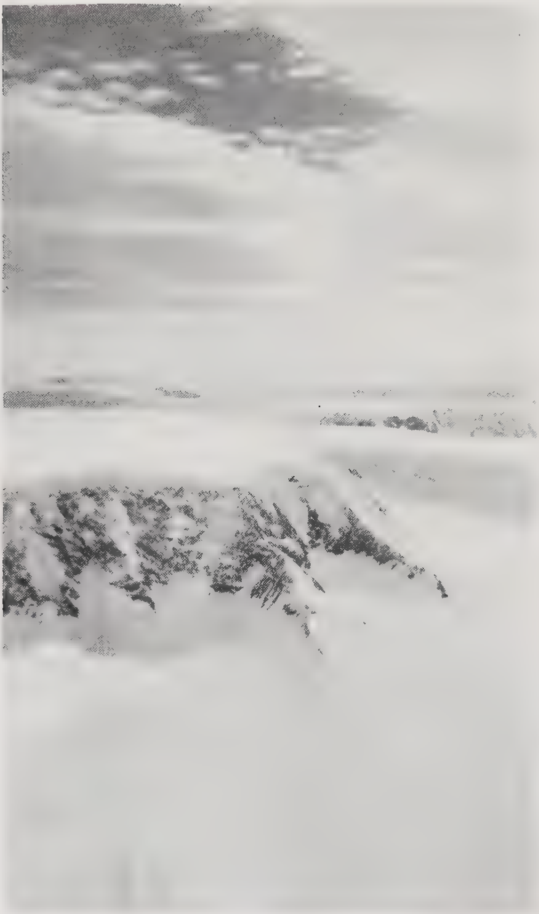

FIG. 35—Storm clouds developing over Graham Land.

THE RETURN FLIGHT

Meteorological conditions became interesting. Three cloud areas were developing. One was to the west of us in the southern Pacific Ocean; a lesser one in Belgica Strait, halfway back to our base; and, as we traveled farther north, low in the distance another storm area could be seen developing west of Deception. Before we were halfway back we felt the influence of the wind. First it was from the south, then from the east, and then we entered a calm belt. As we neared Deception we met northwest wind and with it cloud. To the south in De Gerlache Strait the sun, reflected in the sea, illumined Brabant Island and the coast of Graham Land. Ahead the clouds were almost solid and, streaming out, hid Deception Island from our view. We kept a compass course and when nearing the island caught a glimpse of its coast.

From 5000 feet above we saw through a hole in the clouds our landing field, and Eielson threw the machine into a sharp spiral nose dive and landed safely within ten hours of the time we started. Our ground speed on the return trip, helped a little by a wind behind us, averaged more than 130 miles per hour. All through the day until we descended at Deception Island the temperature in the cabin of the plane was never below 64° F. When we descended we began to feel the cold. The temperature had been warmer at higher altitudes, but we were no doubt more susceptible to the cold at the end of the journey. We had been working hard for many hours before the actual start of the flight, and for ten hours we had flown through conditions of absorbing interest.

An Exceptional Season

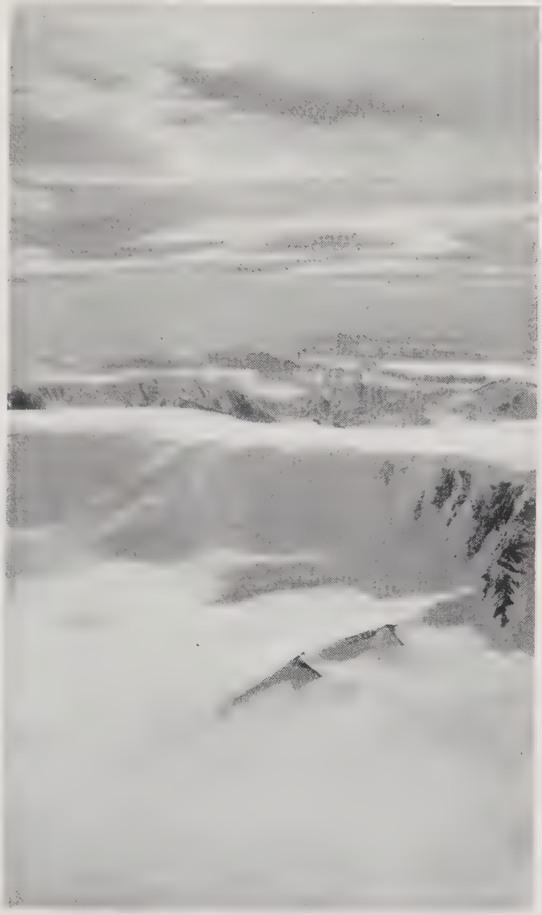

Fig. 36—Clouds over De Gerlache Strait.

During the first part of the flight we passed over country from which so much snow had melted that it was not possible to judge anything with regard to the winter snowfall. At the north end of the Nordenskjöld Shelf Ice we were at such high altitudes that the snowdrifts were not conspicuous. Nearing the most southerly point on our flight we noticed that the drifts had been formed when the wind was from the north and that across these were drifts formed in a westerly wind.

On January 10 we made a second long flight over Graham Land—250 miles out on more or less the same course—and confirmed the observations made on our first flight. We could not, however, expect to get off with a greater load than we had carried on our first long flight, and it was deemed advisable to postpone further effort until next season. By going south early in the season we can expect to use the ice in the harbor at Deception Island. We believe it is possible to make landings on the shelf ice with skis. We propose to fly to a point five or six hundred miles south of Deception and there await the favorable time to cross to the Ross Sea. The N. Bugge Hektor Whaling Company has generously agreed to carry us again next season to Deception Island, where our machines and supplies are stored in a warehouse. We are expected to be ready to join the boat at Montevideo some time next September.

Everything except the earliness of the season was as we expected to find it in the Antarctic. The season was no doubt three weeks or a month earlier than normal, and little snow had fallen throughout the preceding winter. Another disappointment was the fact that a spare whale catcher, which is for use only in emergency and is the customary equipment of the Hektor Company at Deception Island, could not this year accompany us. I had planned to hire the spare catcher if necessary to help us in our work. It was not available; and it was not advisable from any point of view to hire at great expense a "working" catcher upon which the whole crew of the Company were dependent for their livelihood. The boat-for-hire problem will be solved next season, I hope, through arrangement with the Governor of the Falkland Islands Dependencies, who has promised to recommend that the Hektor Whaling Company be licensed to use an extra catcher with the understanding that it will be placed at my disposal if necessary. This is an arrangement to which I believe the Company will be agreeable.

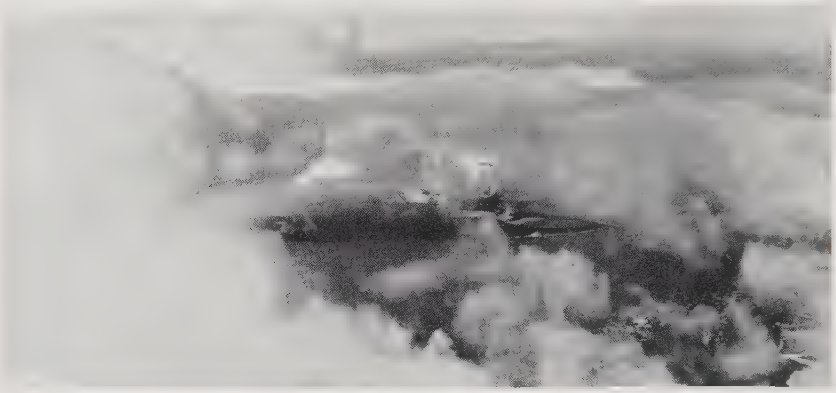

FIG. 37—Looking down from 5000 feet to the landing field on Deception Island.

APPENDIX

EDITORIAL NOTE ON THE HISTORY OF DECEPTION ISLAND

Deception Island, a sea-breached crater, early excited interest as a "curious phenomenon of nature," as Fanning says in his "Voyages Round the World" (1833), and the best harbor in the South Shetlands. The actual discovery and naming of the island are obscure. Mr. Edwin Swift Balch, in an article "Stonington Antarctic Explorers" in the *Bulletin of the American Geographical Society* (Vol. 41, 1909, pp. 473–492), gives the romantic account of the first American entry into the rich sealing grounds of the South Shetlands in 1819 as he obtained it from a descendant of the hero of that occasion, Nathaniel B. Palmer. Certain is it that five American vessels, among them one commanded by Palmer, were in "Yankee Harbor," Deception Island, in the summer of 1820–1821, where they were encountered by Bellingshausen.

In January, 1829, Deception was visited by the *Chanticleer*, Captain Henry Foster, who used the island as a pendulum station in his voyage to collect data for determination of the figure of the earth. Graphic descriptions of its volcanic features were written by the ship's doctor, W. H. B. Webster, and Lieutenant Kendall. The latter made a survey of the island and left there a minimum thermometer. Fogs are so frequent, he says, that for the first ten days they saw neither sun nor star. Another brief account is by Lieutenant Robert E. Johnson, of the Wilkes Expedition, who visited Deception in 1839. He failed to find the thermometer left by the *Chanticleer*, but it was recovered three years later (minimum temperature of –5° F.) by the sealer William H. Smiley. Smiley wrote that "the whole side of Deception Island appeared as if on fire" and expressed his opinion that the island was undergoing many changes.

In January, 1905, the Argentine vessel *Uruguay* put into the harbor of Deception Island after relieving the meteorological observers on the South Orkneys and noted various changes in its configuration, particularly in Pendulum Cove where the former narrow inlet, "shaped like a comma," was almost entirely filled with ice and ashes. A map showing the change accompanies R. C. Mossman's short account of the voyage (*Scottish Geogr. Mag.*, Vol. 21, 1905, pp. 323–328). The following season marks the entry of modern Norwegian whaling into the South Shetlands waters (see the article by Gunnar Isachsen in this number of the *Geographical Review*). Deception Island, which provides the only site suitable for a shore factory, has thereafter been regularly occupied during the summer months.

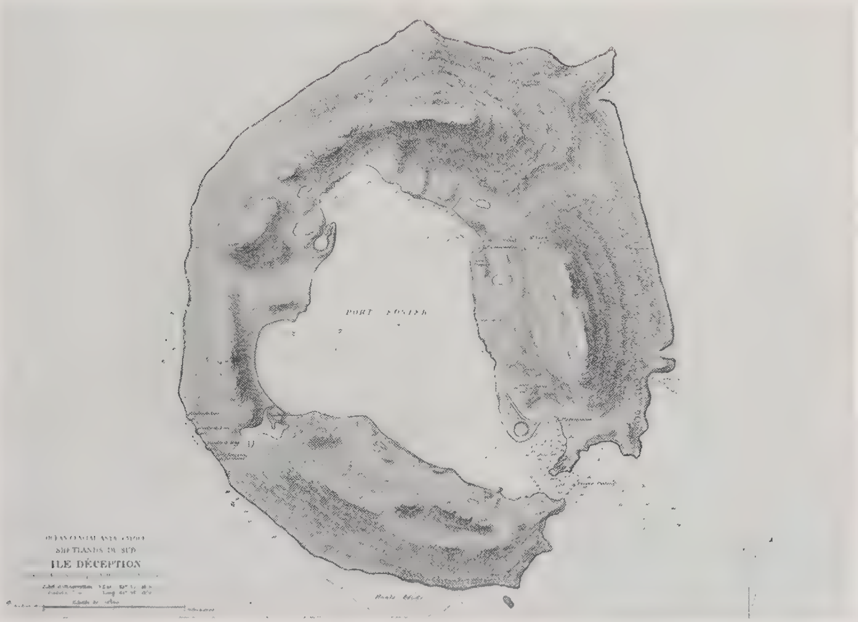

FIG. 38—Reproduction on a scale of approximately 1 : 200,000 of the French Hydrographic Chart No. 5449 (edition of 1912), from the survey executed by the second Charcot Expedition, 1908–1910. Our runway on the western side of the whaling anchorage has been added.

Charcot's second Antarctic Expedition spent several weeks on Deception in the summer 1909–1910 (see his narrative "Le Pourquoi-Pas? dans l'Antarctique, 1908–1910," Paris, 1910). The geologist of the expedition has given a brief description of the island, and its rocks have been analyzed. It is entirely composed of fragmental ejecta and lava. An enormous lava dike in the vicinity of Whaler's Cove suggests an ancient volcanic neck, but it is difficult to determine the center of eruption. There are abundant fumaroles with a temperature of 90° C. Only a single glacier, on Mt. Pond, the highest point, is worthy of the name; here layers of ice alternate with layers of ash (compare Figs. 12 and 13). Erosion is intense: torrents sweep down the loose material, and the wind plays an even more important rôle; and the contours of

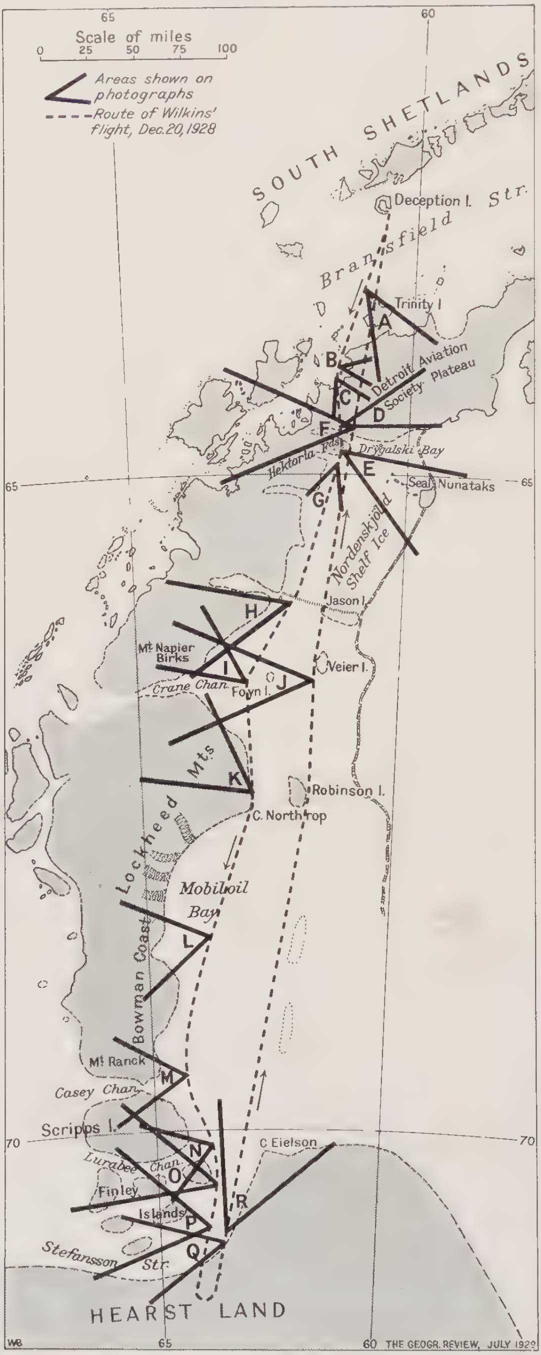

FIG. 39—Map showing location of photographs (by letter) and route of the flight of Dec. 20. A corresponds with Fig. 18; B, with Fig. 10; C, with Fig. 11; D to R, with Figs. 19 to 34. Scale approximately 1 : 6,400,000.

the interior bay are incessantly being modified.

Of particular interest are the meteorological observations by Jules Rouch. Hourly observations were taken on Deception from November 28, 1909, to December 22, 1909, and again from December 31, 1909, to January 5, 1910. The mean of temperature readings for the former period was 0.7° C. (33° F.), for the latter period 2.9° C. (37° F.). Rouch notes that during the interval between the two sets of observations thawing had progressed very rapidly: on the return of the *Pourquoi-Pas?* after the week's absence, "the slopes of Pendulum Cove which we had left snow-covered were almost completely uncovered." Rain was recorded on several occasions, and for only one whole day was mean cloudiness less than 5. During the last week of December and for the period January 6 to March 7 general meteorological observations were made by a doctor at the whaling station. Out of 276 observations (four a day) 28 were recorded as clear; 21 partly cloudy; 155 cloudy; 72 rain or snow. Elsewhere it is noted that the season 1909–1910 was unusually warm in western Antarctica. Comparing the years 1905 and 1909, Dr. Mossman (Meteorology in the Weddell Quadrant During 1909, *Scottish Geogr. Mag.*, Vol. 26, 1910, pp. 407–417) points out that mean temperatures at the South Orkneys and the west coast of Graham Land were much higher in the latter year.

Acknowledgment and Equipment

I was able to organize the Wilkins-Hearst Antarctic Expedition with the support and sponsorship of the American Geographical Society, through the good offices of the Detroit Aviation Society, the financial aid of Australian and English friends, a gift of $10,000 from the Vacuum Oil Company of Australasia, the sale of news rights to Mr. William Randolph Hearst's Universal News Service, and the promise from the N. Bugge Hektor Whaling Company of Tönsberg, Norway, to carry our machines and crew to Deception Island. Our equipment consisted of the Lockheed Vega monoplane we had used on our Arctic flight and a duplicate new Lockheed plane and accessories supplied by the Lockheed Aircraft Company.

We provided pontoon, ski, and wheeled landing gear for the planes and adequate spare parts for the Wright Whirlwind engines. The Vacuum Oil Company provided adequate supplies of Mobiloil B. and Plume gasoline. Mr. T. R. Conway of Portland, Ore., gave some Alpine climbing gear, Mr. Henry Hughes of London presented me with special compasses and drift indicators for navigation. The Worumba Company of New York gave us some splendid outfits made to our design in suitable camel's-hair cloth. Mr. William Horlick presented us with all the malted milk we required. The Freia Chocolate Company of Norway gave us much excellent chocolate, and the remainder of our supplies and equipment was purchased at a discount from Abercrombie and Fitch and from Anthony Fiala, New York. The American Geographical Society, in addition to a contribution toward the cost of the expedition, provided charts and curves and tables for aiding and simplifying navigation.

The Munson Line generously gave us free freight and half fares for the members of the expedition from New York to Montevideo. At the request of the British Minister, the Hon. R. Scott, and Mr. Parry, his first secretary, the Uruguayan Government gave us many facilities and much assistance, placing a guard over our machines during a temporary delay and giving us the facilities of the port. The Port Captain, Captain Taylor, rendered us much assistance. Dr. Bazano, of the Meteorological Service, gave us photographic copies of charts and much information. With the sanction of the Director of the Argentine Meteorological Service, Mr. R. C. Mossman compiled a comprehensive meteorological summary for our benefit. The help of every one of the companies, countries, societies, and individuals mentioned cannot be too highly commended. There are others also, far too many to mention individually, who have helped in countless ways; and it would please me greatly if they would realize my sincere gratitude for their kind assistance.

I must draw attention to the splendid attitude shown by the N. Bugge Hektor Whaling Company and its employees throughout this season. They were always willing to help, in fact, more willing to help than I was to allow them to interfere with their regular duties. In particular, I must mention Captain Marinius Hansen, Secretary Sverre Neilsen, Dr. Henriksen, and First Mate Thorbjornsen.

I also wish to mention the efficient service of Victor Olsen, our wireless operator, and the splendid coöperation we received from Messrs. Roebuck and Martin, of the *San Francisco Examiner's* short-wave radio staff. It has been a pleasure to work with such willing and efficient people. The help received, of which mention is made above, together with the ready and expert service from Eielson, Crosson, and Porter, each of whom has promised to return to the field next season, has made this year's expedition one outstanding for its absence of friction.

Note on the Map

Plate IV (facing p. 374) reproduces on a reduced scale a portion of the revised American Quadrant sheet of the American Geographical Society's Map of the Antarctic, 1:4,000,000. It incorporates my interpretation of the west coast of Weddell Sea as seen from the air. The flight was made for reconnoitering purposes only. The outline of the coast was sketched in relation to recognizable features on the printed chart and checked by dead reckoning. It cannot be considered complete. Only one set of altitudes was taken at the beginning of the flight when immediately west of Trinity Island, shown on the chart at 63° 45′ S. and 60° 45′ W. The result has been worked out at the American Geographical Society. The altitude used for plotting the resulting position line was the mean of five observations of average precision; and so it is unlikely that the error in the observed altitude exceeds 10′ of arc. In addition the sun's apparent time was accurately known. Therefore it may be assumed that position at the time of the set of observations is somewhere within a band extending ten miles on either side of the position line.

Our set of altitudes, it is believed, was the first astronomical observation in the vicinity of Trinity Island controlled by an accurate knowledge of standard time, previous expeditions not having the advantage of radio time signals; but the plotted position line cuts latitude 63° 45′ S. at approximately 56° W. instead of longitude 60° 45′ W. However, no final reliance can be placed on this one position line, and it remains for future observers to determine whether or not the whole of the region about northern Graham Land is too much to the westward.[6]

Although it was not possible to make any astronomical observations at the southerly end of the flight, it is believed that the features there plotted are not likely to be more than five or ten miles out of position in latitude in relation to recognizable features on the American Geographical Society's map. The location in longitude of the features along the southern half of the flight may be subject to greater error.

The new place names upon Plate IV are: Detroit Aviation Society Plateau; Hektoria Fiords (after S. S. *Hektoria*); Evans Inlet (after E. S. Evans of Detroit); Cape Fritsche (after Carl B. Fritsche of Detroit); Cape McCarroll (after H. G. McCarroll of Detroit); Mt. Napier Birks (after Mr. Napier Birks of Adelaide, Australia); Crane Channel (after C. K. Crane of Los Angeles); Cape Northrop (after Jack Northrop, the designer of our Lockheed plane); Lockheed Mountains (after the Lockheed Aircraft Company); Whirlwind Glaciers (after the Wright Whirlwind engines designed by Colonel Laurence); Mobiloil Bay (after the Vacuum Oil Company of Australasia); Bowman Coast (after Dr. Isaiah Bowman, Director of the American Geographical Society); Mt. Ranck (after T. V. Ranck of the Hearst general management); Robinson Island (after W. S. Robinson of London and Australia); Casey Channel (after Major Richard Gardiner Casey of Melbourne, Australia); Cape Keeler (after Fred E. Keeler of the Lockheed Company); Cape Mayo (after William B. Mayo of the Ford Motor Company); Scripps Island (after William Scripps of Detroit); Miller Point (after George E. Miller of Detroit); Cape Walcott (after Frederic C. Walcott of the Council of the American Geographical Society); Lurabee Channel (after Lurabee Shreck of San Francisco); Finley Islands (after Dr. John H. Finley, President of the American Geographical Society); Stefansson Strait (after Vilhjalmur Stefansson); Cape Eielson (after my friend and companion Carl B. Eielson), Hearst Land (after William Randolph Hearst).

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[6] It may be noted that the 1925–1927 *Discovery* expedition confirmed the plotted position of Deception Island (according to Lieut. Commander Chaplin, *Geogr. Journ.*, Vol. 72, 1928, p. 233), the latest published determination of which is that made on the second Charcot Expedition, 1908–1910, of a point near the harbor entrance in 62° 55′ N. and 60° 38′ W. of Greenwich (French Hydrographic Chart No. 5449, edition of 1912). Wilkins' compass course from Deception Island to Charlotte Bay (on the west coast of Graham Land in latitude 64° 20′) past the western side of Trinity Island is given as 190°, or about S. 25° W. true, in his log book in the possession of the American Geographical Society, and the distance to Trinity Island as 48 miles. If the charted position of Deception Island is correct, then this bearing and distance confirm the position of Trinity Island as shown on the latest charts (e. g. British Admiralty No. 3205, revised to 1928).—EDIT. NOTE.

THE SIGNIFICANCE OF SIR HUBERT WILKINS' ANTARCTIC FLIGHTS

Hugh Robert Mill

AS the pioneer of exploration by aircraft in the Antarctic regions Sir Hubert Wilkins has demonstrated the practical value of his methods in a field of peculiar difficulty. He chose that portion of the Antarctic regions where land was first discovered and in which ships have traded and explored for more than a century, yet in four and a half hours of flying he obtained such a view of the geography of an area of more than 100,000 square miles as could not have been constructed from all the records of all the explorers that went before him.

Three physical conditions have combined to retard and perplex Antarctic exploration, though in recent years some of them have lost much of their ancient power. First, there is the remoteness of the region from established trade routes and ports offering facilities for equipment. Secondly, the climate has frequent interchange of gales and fogs, and there is but a small part of the year when the long summer daylight allows of reasonably safe navigation in uncharted waters. Bad visibility and mirage often spoil the angular measurements used for determining heights and distances on the surface and astronomical observations for position. All the blurred impressions so produced have naturally built up a vague and shifting picture in which it is always difficult and often impossible to reconcile the reports of different voyagers. The third difficulty is that presented by sea ice and icebergs, whose distribution and periods vary in the most baffling manner. Thus it is not surprising that most of the land in West Antarctica has been sighted in fitful glimpses as it loomed out of the mist, and one landfall may never have been seen in its true relation to another situated not far from it.

Geographers have too often fallen into the easy error of their sixteenth-century predecessors and sketched in hypothetical coasts without a clear indication of how much has been seen and how much assumed. It follows that each successive explorer has more than enough to do in correcting the defective charts of his predecessors before plotting his own discoveries to puzzle whoever has to follow in his track, and so it is not irrelevant to look at the order in which the outlines of West Antarctica have been felt out before the coming of the Lockheed planes.

A Century of Discovery

When Captain Cook completed his second voyage of circumnavigation he passed the region of West Antarctica in too low a latitude to make any discovery of land there; but by lighting on the Isle of Georgia (now called South Georgia) he made known to the world the wealth of the region in seals, and an active fur trade sprang up before the end of the eighteenth century—the sealers hailing from New England as well as from British ports. They may possibly have visited the nearer islands of West Antarctica before the discovery of the South Shetlands by William Smith in 1819 and the first survey of the neighborhood by Mr. Bransfield of the Royal Navy in the following year when the coast south of the South Shetlands was named Trinity Land. Bellingshausen with the Russian South Polar expedition approached the South Shetlands from the southwestward in 1821 after finding the first land known south of the Antarctic Circle, Peter I Island and Alexander I Land, both in nearly 69° S. He met the American sealers, notably Nathaniel Palmer, quite at home amongst the islands and on the coast to the southwest which appeared to be a mainland and was named Palmer Land by Powell probably in ignorance of Bransfield's work.

In 1823 Weddell, taking advantage of a uniquely ice-free year, reached 74° S. on the meridian of 34° W. Morrell, the most entertaining if not the most trustworthy of the American sealers, spoke of navigating the same sea in the same year and of having killed seals on the coast of a land named by Johnson, a senior in the American sealing trade, New South Greenland, in longitude about 50° W. The crater bay of Deception Island or one of its many coves was already known as Yankee Harbor, and there are few more fascinating records of exploration than that compiled from the logs of the Stonington sealing fleet by Mr. E. S. Balch. *H. M. S. Chanticleer* in 1829, in the course of the first geodetic observations in the subantarctic area, fixed the position of Deception Island and took possession for the British Crown of the extensive land to the south then known as Trinity Land or Palmer Land and renamed Clarence Land by Captain Foster. In 1832 Biscoe with two of Enderby's sealing vessels, following nearly on Bellingshausen's track, discovered and named Graham Land on the Antarctic Circle and a chain of islands running parallel to its coast, Adelaide Island just south of the circle and the Biscoe Islands continuing to the northward. It appeared possible that Graham Land was the west coast of an extensive land mass that stretched eastward to New South Greenland and northward to Trinity, Palmer, or Clarence Land. In 1838 Dumont d'Urville with the French expedition failed to penetrate Weddell Sea but discovered Joinville Island and Louis Philippe Land from the eastward at the northern extremity of what ultimately came to be called the

Graham Land peninsula. Wilkes in the United States exploring expedition, in ignorance of Dumont d'Urville's prior discovery, sighted the same land in 1839. These discoveries were confirmed by Ross in the *Erebus* and *Terror* while returning from his great Antarctic voyage in 1843, and he also penetrated to some distance into Weddell Sea.

In 1874 the first steam vessel to enter these waters, the German sealer *Grönland* under Dallmann, pushed her way to nearly 65° S. on the west side of Graham Land and reported that such charts as existed were quite untrustworthy. Next, in 1892, came four Dundee whalers seeking to reëstablish the whaling enterprise of their port, but they found their gear, which was adapted for killing the Greenland right whale, useless against the great blue whales off the coast of Louis Philippe Land.[1] C. A. Larsen, in a Norwegian whaler, was sent out by a Hamburg firm in the same year to the same region, and in 1893 he returned with two other Norwegian vessels. Then in the *Jason* he penetrated Weddell Sea south of Joinville Island and traced the coast line of a mountainous land, which he named after King Oscar II, as far south as 68° S. If this land was the New South Greenland of the American sealers, as seems probable, it was situated 10° farther west than originally reported. In any case it was probably the east coast of Trinity Land and Graham Land. The mountainous country rose from a broad shelf or barrier of ice which prevented Larsen from landing on it, but he fixed the position of several mountains and islands. At the same time the *Hertha* under Evensen penetrated Bellingshausen Sea and reached 69° S., passing the Biscoe Islands and sighting Alexander I Land.

In 1897 Gerlache in the *Belgica*, the first exploring vessel to commence the modern systematic exploration of Antarctica, made a remarkably accurate running survey of the complicated islands and channels along the Graham Land coast, which had never previously been charted. The work he did was corrected and extended by Dr. Jean Charcot in the *Français* in 1903–1905 and in the *Pourquoi Pas?* in 1908–1910, discovering new land to the south and west of Alexander I Land. Meanwhile the expedition of Otto Nordenskjöld on the east coast in 1901–1903 filled in some details in the northern sections and made some corrections of the map nearly as far as 66° S., while Dr. Bruce, in the *Scotia*, for the first time outdistanced Weddell and discovered Coats Land in the south of Weddell Sea. Filchner in the *Deutschland* in 1912 and Shackleton in the *Endurance* in 1915–1916 carried the southern shore of Weddell Sea to 78° S. and, by their involuntary drifts northward on parallel courses about 200 miles apart, practically negatived Bruce's theory that Morrell Land, or

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[1] See the following article "Modern Norwegian Whaling in the Antarctic," by Gunnar Isachsen. —EDIT. NOTE.

New South Greenland, was an extensive island or archipelago in the longitude alleged for it.

The enormous development of modern whaling led to a wider and more precise knowledge of the western side of Graham Land, some of the whalers of the Scottish firm of Salvesen reporting the existence of a great strait or channel leading eastward in about 70° S.[2] Surveying vessels of the Falkland Islands Dependencies have also been pursuing systematic coast surveys, and the map was in a favorable state of development. Then Sir Hubert Wilkins arrived to take a birds'-eye view of the situation.

Entry of the Airplane

Up to this time the breadth of Graham Land could only be guessed by reference to the few satisfactory longitudes observed on or near the two coasts, its eastern side being unvisited south of 68° S. and no expedition having ever penetrated to the interior or attempted to cross the backbone of high land. It was generally held that the peninsula was an offshoot from the great Antarctic plateau supposed to extend from the pole to the neighborhood of the Antarctic Circle or at least to 78° S. all round, though some theorists suggested a possible water connection between Ross Sea and Weddell Sea dividing the Antarctic into two separate land masses, Graham Land being the northern tip of one and Victoria Land that of the other.

It would be too much to claim that the two flights made from Deception Island have solved any of the great Antarctic problems which have been puzzling explorers and students for generations past; but they have done more to suggest possible solutions and to point the way to future investigations than any other two-days' work since exploration began. The difficulty as to a suitable starting place was inevitable when the base had to be on Deception Island. If it had been possible to land the planes and stores on a large level stretch of snow well within the Antarctic circle and to pick them up again at the end of the season, the amount of work done might have been substantially greater; but to ensure this result the expedition must have had a big ship of its own and a plan of action similar to that of Commander Byrd's expedition.

I feel strongly that the future of aircraft in polar exploration depends on the invention of an effective airplane which can rise vertically or at a very steep angle and descend similarly on a restricted space, thus making landing practicable at will even in rough country.

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[2] In the March, 1929, number of the *Geographical Journal* Mr. J. M. Wordie discusses this report, which is contained in a letter by Mr. H. K. Salvesen appearing in the *London Times*, Jan. 5, 1929, p. 8. It is based on independent observations of two whale catchers in February, 1924. In both cases the opinion was "that the Fallières Coast turned sharply in an easterly direction and that there was here either a channel to the Weddell Sea or at least a very extensive bay or sea."

Until such machines have been perfected serious exploration is confined to airplanes dependent alternatively on wheels, skids, or floats according as a smooth runway over land, snow, or water is available. Whatever possibilities there may be for exploration by lighter-than-air craft in the Arctic regions, there can be none for many a long day in the Antarctic on account of the immense distances which must be traversed to and from any possible base and the terrific force of the Antarctic winds.

I confess that my chief fear for Sir Hubert Wilkins when he started on his expedition was that his enthusiasm might outrun his discretion and that he might attempt a long flight trusting to luck for a safe landing at the far end. I consider it one of his greatest triumphs that he made sure of his return with the modest gains of a few well conducted flights as a guarantee of greater results later when the fruits of experience have matured.

Problems of the Graham Land Region

No line towards the South Pole in the neighborhood of the Antarctic Circle can present more interest to the aerial observer than that along the axis of Graham Land. Here the two coasts had been felt out separately in conditions of extraordinary difficulty, but they had never been connected by sea or by land; so that it was impossible to say what the breadth of the peninsula really was from point to point. Similarly no opportunity had ever occurred before of testing the existence of channels dividing Graham Land into a series of islands, although on more than one occasion western inlets had been observed which sailors had recognized as leading to possible straits. Wilkins was able in his first flight along the eastern side of Graham Land on December 20, 1928, to see both coast lines at the same time, in the north at least, and to look down upon the quite unknown central plateau occupying the northern section, thus uniting the work of Larsen and Nordenskjöld on the east with that of Biscoe and Gerlache on the west. He was able also to state that Graham Land consists of a northern and a southern section and that the southern portion is divided by a wide and well marked strait containing several large islands from the Antarctic Continent or at any rate from some extensive land on the south. He was able to identify most of the islands off either coast, so far as they had been authoritatively mapped, and to descry other islands which had never been seen from the surface. All this was possible in the one day because of the great speed and the great height at which he could fly and because of his experience in the Arctic of the appearance of different ice formations from the surface and from the air.

There still remains in my mind some uncertainty—which, indeed, Sir Hubert Wilkins seems to share—as to whether it is possible to distinguish between actual sea channels blocked with continuous ice and flat-bottomed valleys covered with compacted snow and not depressed below sea level. The point is interesting, although of course it is not the depth of the channels but the geological structure of the land which must be ascertained in order that light may be thrown on such problems as the possible extension of the Andean chain through Graham Land towards the Antarctic Continent. In so heavily glaciated a region it must always remain difficult, if not impossible, to map the border line between land and sea, unless photographs taken from a great height can discriminate between different types of ice formation.

Accepting the track of the airplane as being laid down with the closest possible approximation to accuracy and recognizing the exceptional fitness of Sir Hubert Wilkins to explore and to describe what he has seen, I desire, though with much diffidence, to suggest some points on which he may shed more light. I am not qualified, nor is there room in this article, to discuss fully the changes made in the map and the degree of confirmation afforded by the intensely interesting photographs taken on the flight; and I am most anxious that nothing I may say should appear to cast any shadow on the swift and splendid achievements of the expedition. But a lifelong student of Antarctic exploration necessarily looks on the records of an expedition with a critical eye and requires clear proof before endorsing any claims which, if accepted, might discredit the work of earlier discoverers. An hour's conversation would probably dispose of many of my comments; but, that being impossible, I shall deal in order, from south to north, with the matters suggested by the map.

South of 68° S. Wilkins was over entirely new ground, and his discovery of Stefansson Strait and the islands and channels that separate it from South Graham Land and from the rising land to the south covers a stretch of 200 miles seen by no one before him. Hearst Land may or may not be part of the continent, and it would be preferable to limit it on the map to the range of distinct vision. It would be helpful also to know how far to the westward the great strait was actually seen to extend. For instance, was Alexander I Land sighted?[3] The photographs amply prove the existence of a wide strait with many islands. If the return flight had been made along the western side of Graham Land the connection of Wilkins' discoveries with those of Charcot would have been most useful.

The actual line of the return, well to the eastward of the outward course, enabled a double check to be made on Larsen's discoveries of 1893; and here a description of the land seen in flying north in the altered light would have assisted in the identifications. The descriptions of the land on the outward flight might also have been fuller in view of the interest of a comparison with Larsen's log.[4]

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[3] Since writing this I have had the pleasure of meeting Sir Hubert Wilkins, who tells me that Alexander I Land was not seen as in the southern part of his flight he descended to 2000 feet in order to observe the surface appearances.

Comparison with Larsen's Discoveries

It is obvious that Wilkins' "indications of low snow-covered islands or snow ridges" and his Robinson Island in line to the north of them are a continuation southward of the features which Larsen from the sea close to them took to be the coast of the mainland, "which rose quite evenly from the sea westward to considerable heights." Could Wilkins from his great height in the air be sure that what he took for a flat expanse of barrier ice, 70 miles wide, between those islands and the coast near Mobiloil Bay, was not in fact very low flat land? The equivalent of Wilkins' Robinson Island appears on Larsen's map as a promontory where his coast dips into a large bay westward and then northward to Foyn Land. Wilkins' conception of the relation of Foyn Land, Jason Land, and Veier ("Weather") Island[5] was based on Charcot's general map on which Foyn Land, instead of being represented as on Larsen's map as part of the mainland coast, is implied to be an island. Hence the identification of the island seen opposite Crane Channel (Fig. 26, p. 365) with Foyn Land. But is it not possible that Wilkins' Foyn Island is a new discovery that escaped Larsen because, viewed from his vessel, it merged into the background of the mainland coast? In that case Wilkins' embayment at the head of which lies Crane Channel might well correspond with Larsen's westward reëntrant, and Larsen's high coast to the south with the coast formed by the Lockheed Mountains. Similarly the "very high peak" which Larsen saw nearly W.S.W. of Framnaes is possibly Mt. Napier Birks.

The Question of Through Channels

I cannot free my mind from doubt as to the number of islands into which Graham Land north of Stefansson Strait may be divided. Possibly Crane Channel may not go clear through, for Wilkins does not say that he saw it throughout its whole length; but until disproved by later exploration I am inclined to accept it. I may, however, note that in the very fine photograph of Mt. Napier Birks from the southeast, showing the mountains rising from Crane Channel, the entire foreground is occupied by a heavily crevassed glacier which implies a considerable gradient in the stream of ice and suggests a valley rather than a flat-floored depression. On the other hand the idea put forward by several explorers that North Graham Land is divided by channels leading from sea to sea is rendered improbable by the aerial photographs, though these do not altogether exclude the possibility that the land is deeply cleft between the Richthofen Valley on the east and Dallmann's Bismarck Strait on the west and between Evans Inlet and Flanders Bay.

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[4] See Johannes Petersen: Die Reisen des "Jason" und der "Hertha" in das Antarktische Meer 1893/94 und die wissenschaftlichen Ergebnisse dieser Reisen, *Mitt. Geogr. Gesell. in Hamburg*, 1891–92, pp. 244–305. The Norwegian original, "Nogle optegnelser af sæl-og hvalfanger 'Jason' reise i Sydishavet 1893 og 94," appears in *Det Norske Geogr. Selskabs Årbog*, Vol. 5, 1893–1894, pp. 114–131.

[5] A new map of Larsen's discoveries in 1893 is being prepared in Norway. In conjunction with it attention is called to correction of the name "Weather Island." It should be "Veier Island," named after the home of the man who first sighted the island. Apparently "Veier" was confused with "veir" (weather) in the first German and English accounts of Larsen's discoveries, and the error has been perpetuated.

Two very interesting discussions of Wilkins' preliminary reports in the press have already been made by the men who by general knowledge of the polar regions and special acquaintance with Weddell Sea are the best qualified to deal with the subject, Mr. J. M. Wordie, of the *Endurance* expedition in the *Geographical Journal* for March, 1929, and Dr. R. N. Rudmose Brown of the *Scotia* expedition in the *Scottish Geographical Magazine* for March 15, 1929. Both take up the question of the possibility of Stefansson Strait ever being ice-free and navigable, pointing to the rotary circulation of Weddell Sea as evidence that the southwestern side is normally closed; but they concur in suggesting that some of the anomalies of the ice conditions of that sea might be explained if on exceptional occasions Stefansson Strait were open and allowed the ice from the southern part of Weddell Sea to escape before the prevailing easterly winds into Bellingshausen Sea. Mr. Wordie asks whether the extraordinary feat of Larsen in reaching 68° S. in 1893 might not have been due to such an occurrence in that year, and Dr. Rudmose Brown asks whether the ice-free year 1823, when Weddell reached his high latitude, may not have been due to the same cause.

The demonstration of the high and very flat plateau occupying the central part of North Graham Land ranks in my opinion as a discovery only a little less important than that of Stefansson Strait, and each introduces a series of new problems for geographers to investigate. That a high ice plateau should occupy the center of the great Antarctic Continent or even the huge island of Greenland can be explained from climatic consideration; but how such a condition can arise on a comparatively small island on the temperate side of the polar circle is more difficult to explain. I am not sure that the greatest value of the work done on that eventful day December 20, 1928, is the revelation of a book of questions calling for new research.

I am not inclined to rely on the astronomical observations made from the air, which appear to place Trinity Island four degrees out of its charted position in longitude. It seems impossible that such an error in position in a large island was not detected by the numerous vessels now frequenting Deception Island and the waters to the south.

Future Work

The map compiled by the American Geographical Society (Pl. IV, facing p. 374) seems to have been drawn with skill and care, and it is a new thing in cartography that many hundred miles of coast have been redrawn and a dozen new islands inserted, however sketchily, as the result of one sustained rush through the air at 120 miles an hour. It will take years of laborious work on land and sea or months of systematic aerial survey to test and verify or correct the interesting outline now presented, but I view it as a magnificent pioneer performance redounding to the credit alike of the flyers and of the cartographers who interpreted them. It is good news to hear that Sir Hubert Wilkins, in the coming season, proposes to resume his exploration of the Antarctic by air. If, as he hopes, it is possible to establish a base on Hearst Land by aerial transport, I hope that he will take the opportunity in passing to and fro to make diagonal crossings of Graham Land to link known features on west and east. Will he now also reconsider his plan of flying westward along the coast to King Edward Land and Ross Sea? He may find that the first big piece of work to be done is to connect Hearst Land with Coats Land by a flight towards Herzog Ernst Bay in Weddell Sea, which might go far towards settling the question whether the Antarctic Continent is one continuous unit or two lofty land masses separated by the sea. Of course I recognize that an explorer works best when carrying out his own ideas, and no one will blame Sir Hubert if he prefers to leave the solution of the greatest problem of the Antarctic to a later explorer and confines himself to the very useful endeavor to fix the ocean coast of West Antarctica.

The success of his efforts in 1928 satisfies me that henceforth the employment of small scouting seaplanes with a radius of a hundred miles or so which could rise from the sea in the lee of an exploring ship will be an essential part of every expedition.

Nomenclature of Discoveries

The nomenclature of new discoveries is a theme so tempting and so open to controversy that I feel, like Shakespeare's "poor cat i' the adage," greatly desirous of expressing my views but salutarily cautious as to entering on dangerous ground. I will say that it is right and reasonable for an explorer to wish to enshrine the names of his patrons and friends in prominent places on his map. But I should also like to point out that not all names bestowed by explorers stand the test of time. Weddell's loyalty prompted him to christen the scene of his great feat "George IV Sea"; posterity has decreed that it should be known forever as Weddell Sea. Tasman honored his patron by naming an island Van Diemen's Land; but everyone now calls it

Tasmania. It seems not improbable that the geographers of the future will prefer to call the broad strait south of Graham Land by the name of Wilkins and perhaps the narrow channel farther north after his pilot Eielson.

When names are short, simple, and appropriate there is little reason to doubt that those put forward by the explorer and his sponsors will be adopted by any government exercising territorial jurisdiction. Thus Captain Cook's humorous naming of the first land sighted on the east coast of New Zealand "Young Nick's Head" after the ship's boy, Nicholas Young, who was the first to see it remains unquestioned on the map while many others apparently more worthy of retention have failed to keep their place. The names of men who have done notable work in any region are more likely to be retained in perpetuity than those of others, perhaps much more distinguished in their own sphere, which are given only as a compliment or from a sense of duty. In 1905 I suggested that the name Graham Land might well be restricted to that portion of the land south of the Antarctic Circle.[6] This, it now appears, is Wilkins' South Graham Land. Might I now suggest the revival of Trinity Land, as given by Bransfield in 1820 and used by Weddell in 1823, for "North Graham Land," and the retention of Louis Philippe Peninsula for its northern extremity and the calling of its east coast after Larsen? West Antarctica has become familiar, if not yet official, as the general designation of the whole area.

I have thrown a stone into what may well be the funnel of a geyser and hasten to escape from dangerous ground before I find myself in hot water.

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[6] The Siege of the South Pole, 1905, p. 162.

MODERN NORWEGIAN WHALING IN THE ANTARCTIC

Gunnar Isachsen

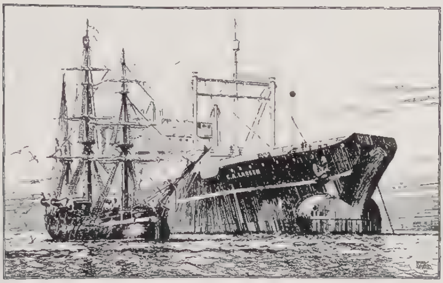

FIG. 1—The *C. A. Larsen*, 13,246 tons, of Sandefjord and the old whaler *Harpooner* of Hull (*c.* 1780), 200 tons. (From a drawing by H. H. Rodmell in the Museum of Fisheries and Shipping, Hull.)

ALL whalers and many scientific folk know by name at least the Norwegian whaling towns Tönsberg, Sandefjord, and Larvik. Among them Sandefjord now holds in Norwegian whaling the place that New Bedford once held in the American industry. Most of the whaling of today is done in Antarctic waters, and the present concern in Antarctic exploration has drawn attention to this industry that offers so much of interest to scientist as well as fisherman.

But, while whaling captains and gunners may talk among themselves of their experiences, they usually are little inclined to write about them. There is no more brotherhood in whaling than in gambling! Like the early sealers in these same waters they keep to themselves discoveries which have to be made over again by others before they become part of our common knowledge. While many corrections in the charts are made from reports by whalers, the most important information they still carry in their heads. True, there have been some notable exceptions, which we shall mention later; and under present arrangements of the authorities concerned, Norwegian and British, we may hope that valuable records will be preserved. Nor in estimating our obligations to the whalers must we overlook the debt owed them by scientific expeditions. The expeditions of Charcot, Filchner, Shackleton, Wilkins, and Byrd have all received valuable assistance, while many smaller expeditions have been aided to such a degree that they have been essentially dependent upon what we should regard as an expression of Norwegian hospitality.

EARLY TYPES OF WHALING

The background of modern Norwegian whaling in the Antarctic lies in the dim past. From time immemorial the Norwegians have hunted seal and whale. The Basques, who had developed a flourishing whaling industry in the twelfth and thirteenth centuries, not improbably learned their trade from the Vikings settled in Normandy and Ireland, with whom they had connections.

The early whaling was shore whaling. As the whale became scarcer it was necessary to seek it farther and farther from land and with larger vessels. At the end of the sixteenth century we find Basque boats hunting whale at Newfoundland, Labrador, and Iceland, and in the beginning of the seventeenth century at Spitsbergen, where they met Dutch, English, German, Danish, and Norwegian whalers. While it was the nordcaper, which took its name after North Cape in Norway, that was hunted in the temperate seas, it was its close relative, the Greenland right whale, or bowhead, that was caught in the Arctic seas. After about thirty years' intensive whaling at Spitsbergen the field of operations moved westward to the ice border in the Greenland Sea, Davis Strait, and Baffin Bay. This whaling lasted on a large scale till the end of the eighteenth century, thereafter declining. As the right whales grew scarce, the whalers had to hunt seals and later the bottlenose as well.

The Scottish whalers discontinued operations before the World War. The last remnants of the once large Dutch and German whaling fleets were a few ships under the Norwegian flag equipped and manned in Norway. The last

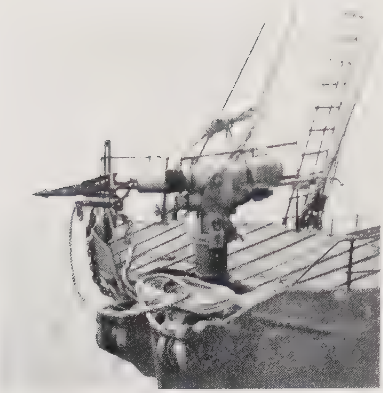

FIG. 2

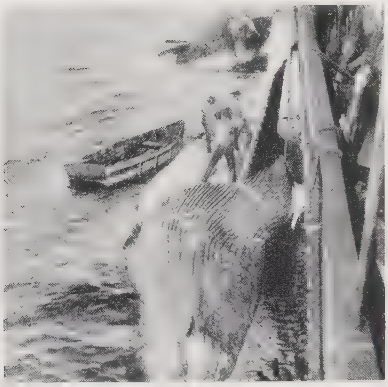

FIG. 3

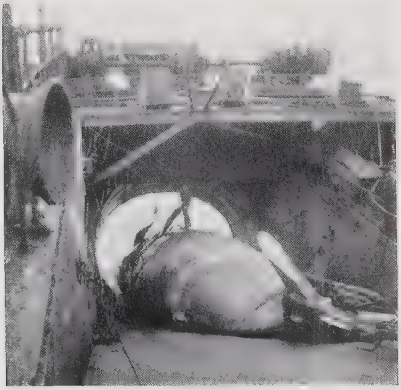

FIG. 4

FIG. 2—A modern whaling gun. (Photograph by Sir Hubert Wilkins; copyright by *New York American* and Universal Service.)

FIG. 3—Flensing a whale at the side of the ship.

FIG. 4—Taking a blue whale on deck of the *C. A. Larsen* by the slip (compare Fig. 9).

Norwegian whaler of this type was the propeller-driven bark *Samson* which now, as the *City of New York*, is Byrd's flagship.

A second type of whaling was begun in the early eighteenth century by the colonists on the New England coast—whaling in the open sea for the sperm whale, a large-toothed whale that occurs in all seas except the Arctic. English and German whalers followed suit. The climax was reached about 1840, when the world fleet counted over 800 whaling vessels, of which almost 600 were American. The trips lasted from one to several years. At the same time the humpback was caught in the shallow coastal waters of Africa, and fur seal and sea elephants in the subantarctic islands. This was the period of the so-called mixed voyages. After 1848 American whalers went all the way to Bering Sea and still farther north to get the bowhead. Marked decline set in about 1860 as competition in other kinds of oil—mineral oil and later also vegetable oil—gradually made whaling less profitable. The hunt of the sperm whale was entirely discontinued during the World War, though there have been a few later attempts to revive it.

The same technique was employed for catching the nordcaper, the right whale, and other related forms occurring farther south (as *Balaena japonica*, *B. australis*, *B. antipodarum*), the sperm whale, and the bottlenose. The whale was approached in a rowboat and made fast with harpoon and line, thereafter being killed with lance or

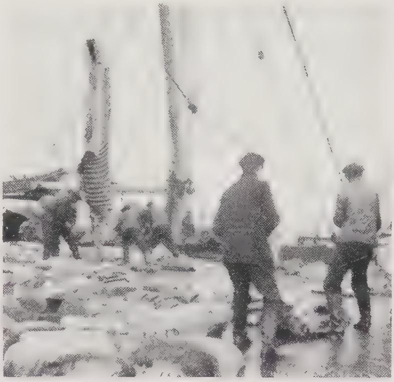

FIG. 5

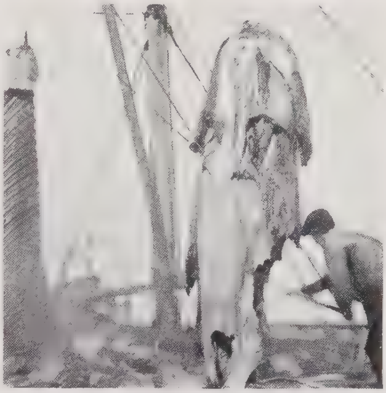

FIG. 6

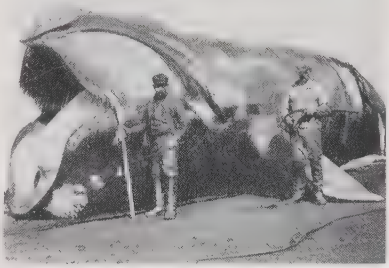

FIG. 7

FIG. 5—Cutting blubber on deck in the Ross Sea, 1927.

FIG. 6—Cutting up the fat tongue. All the whalebone or true whales have a large fat tongue.

FIG. 7—Right whale, Husvik Harbor, South Georgia, 1912.

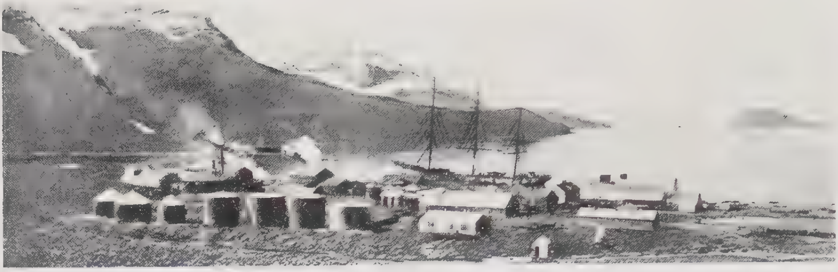

FIG. 8—Whaling station, Strömness, South Georgia, 1910.

bomb. The ships were sailing vessels—schooners, brigs, and barks of 100 to 400 tons burden.

As the old type whaling grew less profitable, attention was naturally turned to the great multitudes of other whales—the blue whale; the common rorqual, or finback; the sei whale; and the humpback. Attempts were made to catch them with the old technique but without success, as these quick wild creatures when wounded set off at terrific speed, and, unlike the right and sperm whales, they do not float when killed.

A NEW TECHNIQUE AND ITS APPLICATION IN ANTARCTIC WATERS

The problem was solved by the Norwegian seaman and sealer, Svend Foyn (1809–1894), whom Dr. Mill has well described as "a man of the most remarkable perseverance, courage and originality."[1] In 1868, after years of effort and expensive experiment, he invented the grenade harpoon, shot with a line from the whaling steamer, the grenade exploding in the whale with killing effect. An air pump by which the whale carcass could be made to float was also invented.

This technique ushered in the third stage in the history of whaling. It began on the coasts of Östfinnmark and by 1886 counted 19 land stations and 35 whaling steamers. As returns gradually decreased in the nineties, some stations were abandoned, while others were moved westward along the coast and later to Spitsbergen. A few companies took up whaling in Iceland, where the industry reached its height in 1902 with 30 vessels and was discontinued in 1915. Grounds at the Faeroes were taken up in 1894, at the Hebrides and Shetlands in 1903, and off the northwest coast of Ireland in 1907. In the nineties whaling was begun in the east Asiatic seas and at Newfoundland.

In the northern seas as a whole the new whaling reached its climax in 1905, when 24 companies with 63 vessels caught 2671 whales that yielded 83,000 barrels of oil besides by-products. Expenses of the industry, however, were increasing to a point when it could no longer be prosecuted with profit. It was necessary to look for new grounds.

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[1] H. R. Mill: The Siege of the South Pole, New York, 1905, pp. 379–380.

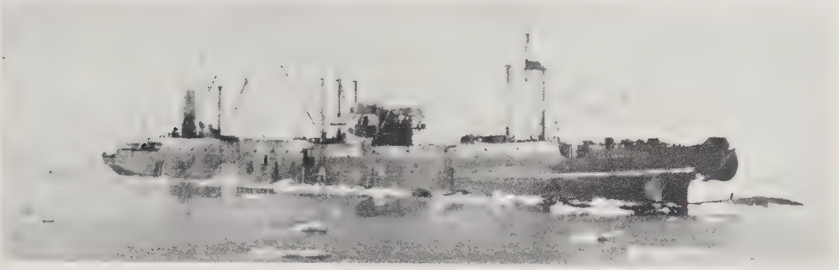

FIG. 9—The *C. A. Larsen*, floating factory ship. Note the slip in the bow and compare Figure 4.

There was a virgin field in the southern hemisphere; but it was a question whether it would pay to send hunting expeditions so far.

In the first place the whaling vessels were small craft for the long and arduous voyage: steamboats of iron or steel, of 60 to 90 tons net register, about 80 feet long and 16 feet wide, and capable of making 9 to 9½ knots. But the whalers had no fears on this ground. In the second place they were dependent on land stations for the reduction of blubber and carcass. Little or nothing was known about possible harbors and land stations in the south or of the ice conditions. Here an alternative solution presented itself: substitution for the land station of a floating factory, free to move as conditions required. After several attempts the Framnaes plant at Sandefjord succeeded in converting the steamer *Admiralen* into a floating factory, which was tried out in the Spitsbergen grounds in 1904 and 1905.

The third and most important question was as to the number of whales in the southern seas. James Clark Ross[2] and many before him had reported great numbers of right whales at the ice borders in the Antarctic seas. In 1892 the whaler *Jason*, from Sandefjord, Captain C. A. Larsen, visited the eastern side of Graham Land just where Ross had reported seeing so many right whales. On December 26 she met three of four Scottish whalers, sent out from Dundee, also in search of the right whale. None of the vessels, however, got any. They saw only blue whales and finback which could not be caught with their equipment. Not to return empty-handed, the vessels hunted seal. The Scotsmen made no further attempt. The Norwegians, however, went south again in the fall of 1893, two other similar vessels, the *Castor* and the *Hertha*, accompanying the *Jason;* but only a few right whales were caught.

Ross had also reported abundant whales in Ross Sea. To investigate the possibilities here the "grand old man" of Norwegian whaling, Svend Foyn, now 84 years old, sent H. J. Bull with the whaler *Antarctic* to spend the season 1894–1895 in that area. No right whales were observed; but, on the other hand, there were great numbers of blue whale. Bull expressed the opinion that the discrepancy between Ross's statement and his own experience was due to the wholesale capture of the right whale on its migrations in more northerly waters; but current whaling opinion is that Ross mistook the blue whale for the right whale.[3]

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[2] J. C. Ross: A Voyage of Discovery and Research in the Southern and Antarctic Regions During the Years 1839–43, 2 vols., London, 1847.

Modern Whaling in the Antarctic

During 1901–1903 Captain C. A. Larsen, as commander of Otto Nordenskjöld's ship *Antarctic*, had again an opportunity of studying the occurrence of whales around South Georgia and the South Shetlands. As a consequence he was led to the formation of the first company for whaling in the southern seas, the Compañia Argentina de Pesca, organized in Buenos Aires in 1904 with Argentine capital and Norwegian equipment, personnel, and technique. Larsen erected a station at Grytviken, on the northeastern side of South Georgia, and began whaling in adjacent waters in December, 1904.

The first Norwegian whaling expedition to the southern seas consisted of the floating factory *Admiralen* already mentioned and of two whale catchers belonging to the Örnen Company, whose manager, C. Christensen, was another of the grand old men of the Norwegian industry. Some hunting was accomplished on the Falkland Islands grounds, thereafter for a month's time and under difficult conditions about Admiralty Bay in the South Shetlands, and then again for a short time about the Falkland Islands. On the first of June the expedition was back in Sandefjord with a full catch. Thenceforth began a rapid expansion of the industry, concentrated on South Georgia and the South Shetlands, the nearest and most accessible groups of islands in the subantarctic regions.

Whaling in the Antarctic is now carried on from Patagonia and the islands on the west side of Graham Land eastward along the border of the pack ice to the longitude of Cape Town, or, in other words, between 80° W. and 20° E., and around South Georgia, the South Shetlands, South Orkneys, and the South Sandwich Islands. It is also prosecuted outside the Ross Sea about the Balleny Islands and in Ross Sea.

South Georgia, the South Shetlands, the South Sandwich Islands, and the South Orkneys are dependencies of the Falkland Islands, and whaling in their waters is controlled by the British government. It can be carried on only by license, purchasable for a fixed sum, which regulates the number of the vessels to be employed.[4] There are also penalties for infringement of the regulations, and an export duty is levied on whale oil and guano. This duty has greatly increased, especially since 1919. The licenses, the number of which was limited to 7 for South Georgia and 8 for the South Shetlands, were all purchased in 1911. Later, two more licenses were granted to British companies for the South Shetlands. The licenses, which originally ran for 21 years and were renewed provisionally for 5 years in 1928, give each one the right to use one factory ship and three whale catchers. Of the seven licenses for South Georgia, two are British, one Argentine, and four Norwegian. Of the ten licenses for the South Shetlands, three are British and the remainder Norwegian. Whaling has also been carried on by a few Norwegian companies at the South Orkneys during the years 1911 to 1915, and a company has operated there during the last three years. In spite of the fact that the ice conditions are worse here and the season shorter, the results have been good.

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[3] H. J. Bull: The Cruise of the 'Antarctic' to the South Polar Regions, London and New York, 1896, p. 218.

[4] Report of the Interdepartmental Committee on Research and Development in the Dependencies of the Falkland Islands, Cmd. 657, 1920. The revenue is devoted in part to development of the industry.

It may be noted that there has always existed a good understanding between the whalers and the British colonial officials, who have been considerate of the opinions and suggestions of the whalers regarding laws for the best use of the catch and for conservation of the whale.

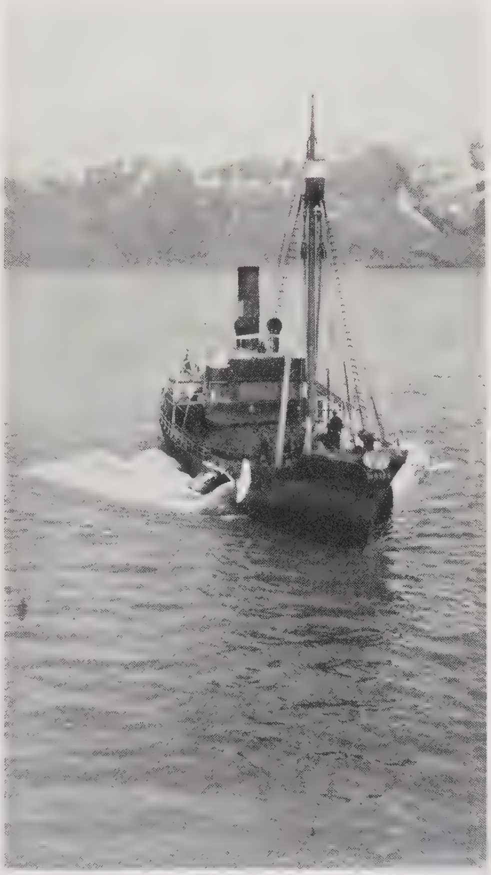

Fig. 10—Whale catcher returning to Deception Island after a successful day's hunt. (Photograph by Sir Hubert Wilkins; copyright by *New York American* and Universal Service.)

Captain Larsen, who in 1904 began the whaling from South Georgia, was also the first to hunt blue whale in the Ross Sea where this kind of whale was found by H. J. Bull's expedition. With the floating factory *Sir James Clark Ross* (12,450 gross tonnage) and 5 whale catchers Larsen spent the season 1923–1924 in the Ross Sea. To gain the open water of Ross Sea he had to cross (December 13–20) a belt of pack ice 600 miles in width. A daring and risky undertaking it was:

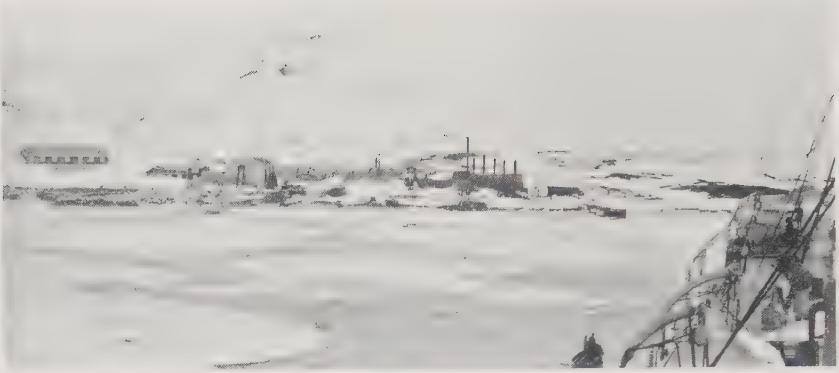

FIG. 11

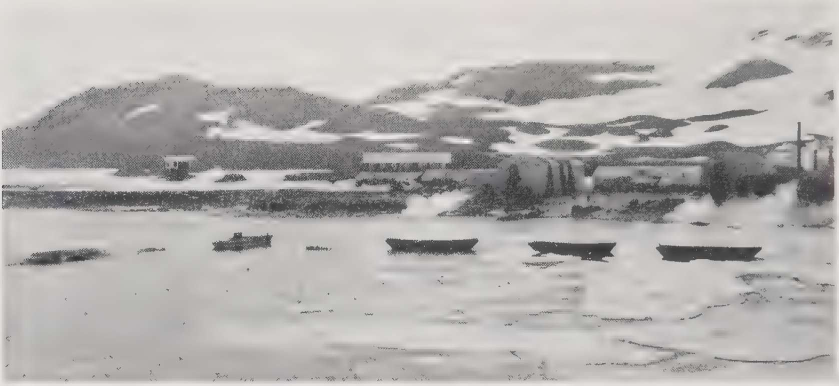

FIG. 12

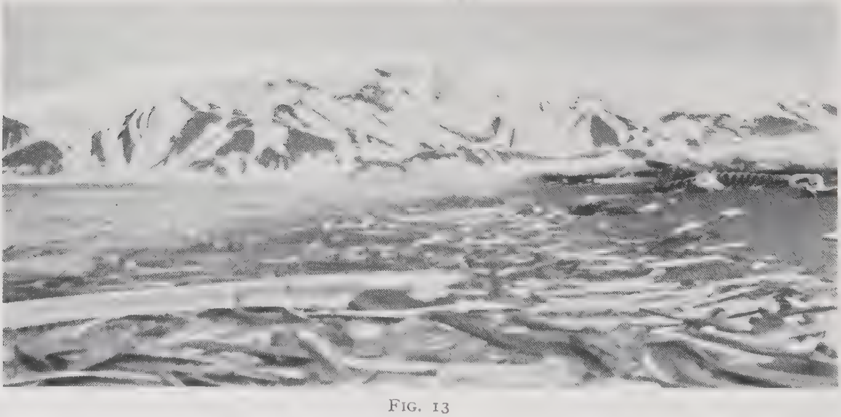

FIG. 13

FIG. 11—The shore whaling station at Deception Island, early November, 1928.

FIG. 12—Small motor boat towing a whale to the slipway.

FIG. 13—Whale bones strewn along the beach, Deception Island. (Photographs 11–13 by Sir Hubert Wilkins; copyright by *New York American* and Universal Service.)

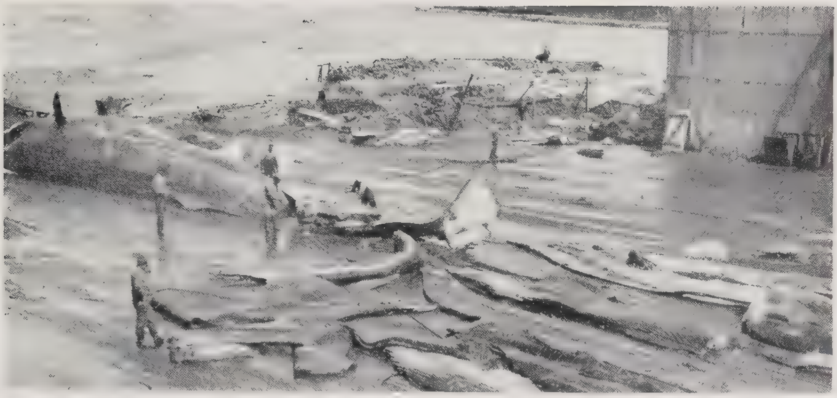

FIG. 14

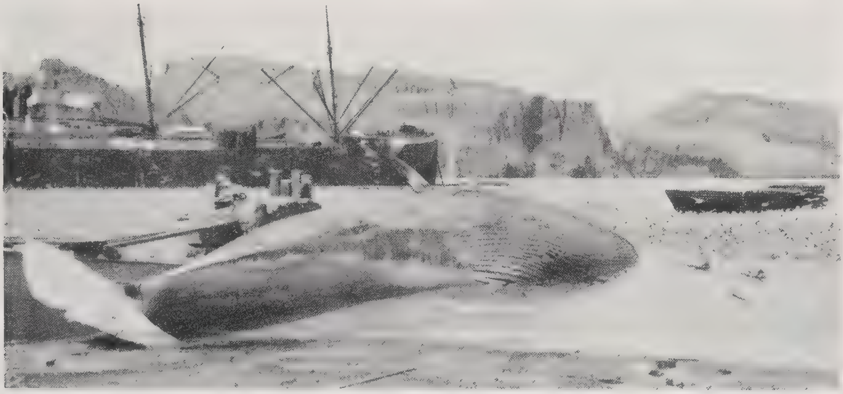

FIG. 15

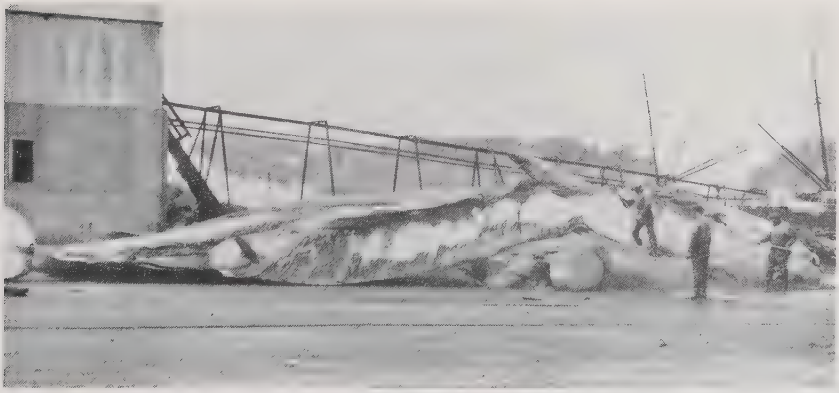

FIG. 16

FIG. 14—Flensing platform of the shore whaling station at Deception Island.

FIG. 15—Whale being hauled onto the flensing platform.

FIG. 16—Stripping the blubber: the second strip. (Photographs 14–16 by Sir Hubert Wilkins; copyright by *New York American* and Universal Service.)

however, all went well.[5] The next year Larsen returned. He died on his ship in the Ross Sea on December 8, but his successful work has been continued. In the season 1926–1927 three floating factories with fifteen whale boats were operating here.[6] The Norwegian whaling fleet in the Antarctic this last season, 1928–1929, worked with three land stations, about 85 whale catchers, 24 floating factories. In April the *C. A. Larsen* and the *Sir James Clark Ross* from the Ross Sea docked in New York carrying cargo valued at $2,000,000 and $1,500,000 respectively. The former had caught 761 whales, the latter 545. The oil obtained was 75,000 and 51,000 barrels respectively, destined for American soap factories.[7]

RECENT DEVELOPMENTS IN THE INDUSTRY

Almost all companies in the southern seas began whaling with floating factories, still used by most of them. In the beginning these factories were steamers of 2300 to 6000 gross tonnage, since only the blubber of the whale was used. For a more rational use of the carcass the equipment has been constantly improved, and the factories have been increased in size up to 12,000 gross tonnage. While the boiled remains of meat and bone at the land stations are dried and prepared for fodder, bone flour, and guano, the preparation of these products is difficult on the floating factories since it requires large space and is at present not profitable. And it is not fully free from fire risks.

At the same time land stations have been erected. Of these there are now one in the South Shetlands, on Deception Island, and five on the northeastern side of South Georgia. They have besides guano factories, repair shops, slipways, warehouses, oil tanks, water supply, and electric light. They have also accommodations for comfortable living and for social gatherings.

The hunting season at South Georgia lasts from the end of September till the middle of May, at the South Shetlands from the latter part of November till the end of April. The floating factories therefore leave Norway between the middle of August and the end of September and are back again between May and July. The whale catchers in this section are laid up and repaired at South Georgia, Montevideo, or Cape Town: the Ross Sea catchers are laid up at Stewart Island, N. Z.

Since the humpback whale is most easily caught, it was the chief kind hunted before 1912. As the supply of humpback had decreased decidedly at this time, blue whale and finback have been hunted since then, the blue whale usually in the first part of the season, and finback in the latter part.

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[5] An account of the voyage with geological, meteorological, and zoölogical observations is given by Ludwig Kohl: Zur grossen Eismauer des Südpols: Eine Fahrt mit norwegischen Walfischfängern, Stuttgart, 1926. See also the narrative of A. T. Villiers: Whaling in the Frozen Seas, Indianapolis, 1925.

[6] The author was on the N. T. Nielsen-Alonso of the Polaris company in 1926–1927. See his book "Jorden rundt efter Blåhvalen," Oslo, 1927.

[7] The commercial uses of whale oil—for soap making, as a substitute for tallow, lard, and margarine, as a lubricant, etc. are discussed in the Report on the Dependencies of the Falkland Islands; see footnote 4.

As was observed in the early history of whaling, so it has been noticed in the Antarctic that the whale extends its area farther from land, not only because winds and currents may drive the food out to sea but also because of the hunting. This again means smaller returns because of the long tow to the stations. It has therefore been necessary to make the whaling steamers larger and more seaworthy and equip them with stronger engines. By 1912 the power had been increased to about 500 horse power; by 1924 to 800 horse power; and since then, in a few boats, to 1000 to 1200. One company last year had a boat of 1500 horse power and has one of 1650 horse power under construction.

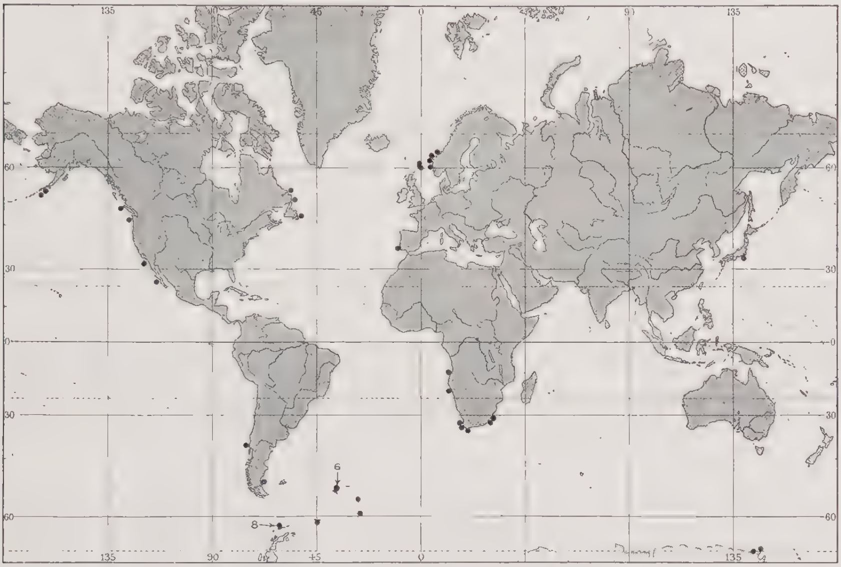

FIG. 17—Map showing the stations of the whaling companies operating in 1928–1929. (After the Register of the Whaling Fleet, Whalers' Mutual Insurance Association, Sandefjord, 1928.)

Parallel with this development of the catchers there has been an evolution in the floating factories. Originally the factories were designed for operation in a sheltered anchorage. Latterly some of them have carried out operations to a certain extent or exclusively in the open sea.

Companies with stations in the South Shetlands were compelled to take up whaling in the ice when conditions in the early part of the season prevented them from getting back to the stations with their catch. During the last few years ice whaling has been extended more and more over the summer and the autumn and, in the present season (1928–1929), has been carried on as long as the whalers could by entering the pack ice find smooth enough water to permit flensing of the whales at the side of the ship. Since the pack ice is melted or drifted away eastward in the latter half of February, and the nights then become dark and the weather stormy, the expeditions that have concessions seek their way by this time to their stations.

However, there are also whaling companies that have no concessions, the so-called pelagic companies. They carry out all operations in the open sea without connection with any station and carry with them coal and a fresh-water supply for the entire trip. When the companies that have concessions leave the ice for their stations in order to extend the hunting period, the pelagic expeditions return home. The fact that the floating factories have been equipped with a slip for hauling the entire whale aboard has more than anything else contributed to the expansion of pelagic whaling. The whale can consequently be treated aboard instead of at the side of the ship, and this not only in smooth water but in fairly rough seas. These factories are of still larger tonnage—12,000 to 18,000 gross. During the next season there will be a floating factory of 22,000 gross tonnage, carrying 7 whale catchers. In 1925–1926 there was only one pelagic factory: there were eight in 1928–1929.

All land and floating stations and whale catchers have wireless, and the catchers and several floating factories have also direction finders. The latter have special radio operators. On the catchers usually the captain or the mate operates the radio. Radios and direction finders are essential instruments for the pelagic whalers.

If in earlier times it was an achievement of the first order to circle the globe with the small whaleboats, it is no less an achievement to pull up onto the deck in open sea the blue whale, sometimes as much as 100 feet in length, the largest mammal living.

Economy of Whaling Industry

From 1906 to 1927 there has been produced at South Georgia 3,830,000 barrels of oil valued at 400,000,000 kroner and at the South Shetlands 2,645,000 barrels of oil valued at 280,000,000 kroner. The total for the Falkland Islands Dependencies is thus 6,475,000 barrels valued at 680,000,000 kroner. An addition from the Ross Dependency (1924–1927) of 199,000 barrels of oil valued at 20,000,000 kroner brings the total for the Antarctic to 6,674,000 barrels of oil valued at 700,000,000 kroner. The Antarctic production of 1928–1929 was about 1,600,000 barrels, which exceeded by 200,000 barrels the entire world production of the previous season.

The finest whale oil is numbers 0 and 1 oil with less than two per cent free fatty acid. In 1924–1925 prices of this oil averaged £35 3s. per ton (about 6 barrels of 170 kilograms); in 1926–1927, £27 10s., and in 1928–1929, £30. The prices per ton of the higher numbers of oil decrease by a few pounds sterling for each number. For instance, number 2 oil costs about £3 less than numbers 0 and 1 oil, and number 3 oil costs about £3 less than number 2 oil.

The non-Norwegian companies have non-Norwegian direction and capital but Norwegian technique and personnel. All personnel are paid with board, salary per month, and part of the catch. This last is paid to the men of the whaleboats per whale according to the kind, and to the men at the land and floating stations per barrel of boiled oil. The captains on the factory ships, the captains of the whale catchers, and the gunners are also paid with wages and part of the catch according to a special agreement. The captains of the factory ships are also as a rule heads of the whole expedition. But in some cases the gunner of one of the whale catchers is the head. The captains of the whale catchers are usually also gunners; but in some cases the mate or a special man, not a member of the crew, is the gunner.

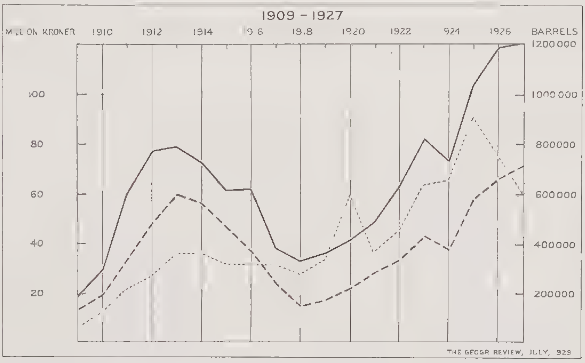

FIG. 18—The whaling industry, 1909–1927. The solid line represents the world's catch in barrels; the dashed line, the Norwegian catch in barrels; the dotted line, the value of the Norwegian catch. (After the Register of the Whaling Fleet, Whalers' Mutual Insurance Association, Sandefjord, 1928.)

A whaling expedition to the southern seas, consisting of a factory ship and three whale catchers, has 80 to 180 men for the ship and 11 to 13 for each catcher. Expenses for an expedition of ten months' duration is from one and a half to three million kroner. In this amount is included the outlay for the yearly inspection and repairs after the heavy wear of the material in sea and ice. On the whole, whaling is a risky business and does not return more than a modest interest on the invested capital. All equipment in the industry is exposed to such wear and tear that it is necessary to set aside larger sums than in most other industries for replacement, especially of whale catchers, which are frequently worn out and antiquated after a few years' use.

In the Antarctic more than 20,000 whales have been killed annually during recent years. In a single year the Antarctic catch represents about 70 per cent of the catch in all parts of the globe. It is fortunate for the preservation of the whale that modern whaling in distinction from the old requires so much capital that a relatively small decrease in the supply of whales will cause a cessation of the industry before it becomes unprofitable or the fisheries are exhausted.

Contribution to Science by Whaling

After his second circling of the globe (1772–1775) between 50° and 70° S., James Cook wrote that there was not the slightest possibility of the existence of a continent here except near the pole and outside the sailing limits. His journey represents the beginning of south polar exploration. A second stage (1812–1843) was introduced by American and English whaling and sealing expeditions. It was completed by the French expedition of Dumont d'Urville in 1838–1840, the American expedition of Charles Wilkes in 1838–1841, and the English expedition of James Clark Ross in 1839–1843.

After these expeditions there were no more for fifty years. Then Norwegian and Scottish whalers introduced the third period (1892-1914). The whaling expedition (1893–1894) of the Norwegian Captain Larsen, already referred to, judged from a purely geographical point of view in comparison with other whaling trips, may be regarded as "one of the richest in results ever undertaken," whether to Arctic or Antarctic regions.[8]

Larsen in the *Jason* made his way southward along the east side of Graham Land, soon reached the highest latitude of Ross at 64° S., crossed the Antarctic Circle, and on December 6, 1893, reached 68° 10′ S., the highest latitude in the eastern Graham Land region until Wilkins' flight in 1928. Larsen discovered much new land and on his return a number of islands, several of which have active volcanoes. He landed on the South Orkneys, Seymour Island, and Louis Philippe Land and brought back in his collections the first fossils from the Antarctic. Contemporaneous with Larsen on his expedition of 1893-1894 another Norwegian whaler, Captain C. J. Evensen, with the *Hertha* forced his way southward along the west side of Graham Land and reached a still higher latitude than Larsen on the east side, namely 69° 10′ S.

H. J. Bull's whaling expedition with the *Antarctic* in 1895 was the first to the east Antarctic after that of Ross in 1842. He was no more successful in finding right whales than Larsen, but, as Sir John Murray has said,[9] the poor economic return of Bull's expedition was fully compensated by the fact that it reached to and made the first

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[8] Otto Nordenskjöld and J. G. Andersson: Antarctica, or Two Years Amongst the Ice of the South Pole, London and New York, 1905, p. 77.

[9] In a letter to H. J. Bull. See also H. R. Mill, *op. cit.*, p. 382.

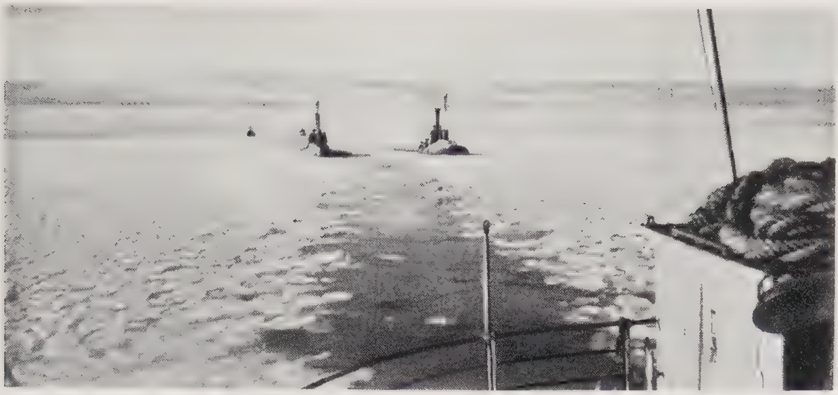

FIG. 19

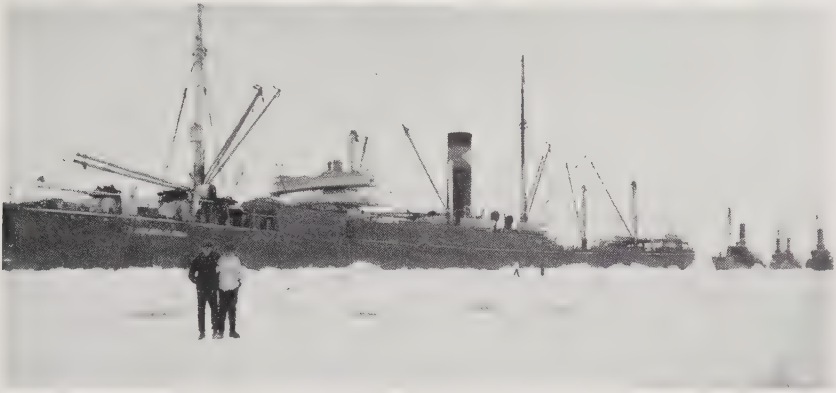

FIG. 20

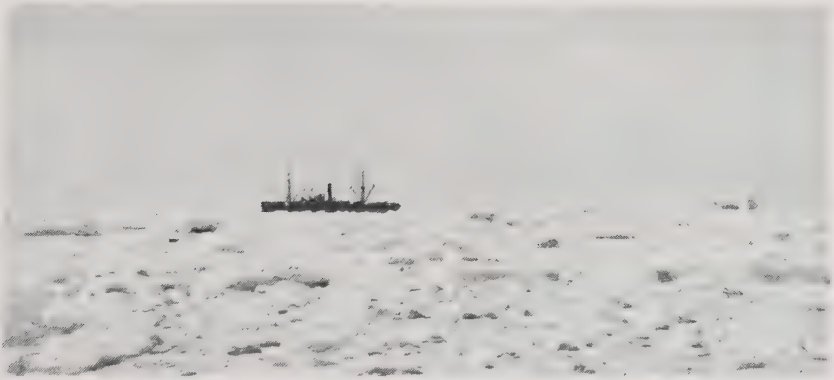

FIG. 21

FIG. 19—New ice beginning to form is the signal for the whalers to leave Ross Sea, 1927.

FIG. 20—The floating factory *N. T. Nielsen-Alonso* (*Polaris*) in the pack ice outside of Ross Sea, December, 1926.

FIG. 21—The floating factory *Falk* operating in the ice, 1927.

landing in South Victoria Land and found that ice-free waters apparently occur normally south of the pack ice.

These Norwegian whaling expeditions described above are of fundamental importance not only for the Norwegian whaling industry but also for modern south polar exploration. Our knowledge of whales, their migrations and propagation, is due to the whalers. It is part of the work of the gunners to know the animals and their habits, to find them and follow them until they are killed. The Norwegian whalers early discovered that whales both in the northern and the southern seas migrate in spring to colder regions and in autumn to warmer regions. They knew that the migrations were undertaken to obtain their food, drifting organisms which in spring develop in such enormous numbers as often to color the water.

At the same time they observed that the migrations are connected with breeding, the bearing of the young taking place in the warmer waters. As far as is known, breeding migrations are the rule, especially as regards the humpback, and also as regards the blue whale and finback, in spite of the fact that the observed embryos suggest that the whale has no fixed mating season.

Since food is scarce in temperate and warm seas the animals grow lean before they return in spring to the abundance of the polar seas. From the opportunities the whalers have had to follow the migrations, they believe that the whale as a rule does not migrate from the southern hemisphere to the northern, or vice versa. From numerous measurements it is evident that the animals are larger in the southern seas than in the northern. It is necessary to study the conditions of existence of the whale and its food from the Arctic to the Antarctic and during different seasons in order to know and explain the animal's distribution; and this knowledge is necessary for a pertinent discussion of the international problem of the future of the whale and the whaling industry.

In 1923 the so-called Discovery Committee was appointed to follow up recommendations of the Inter-Departmental Committee on Research and Development in the Falkland Islands (1920). Captain Scott's old ship, the *Discovery*, was acquired for field study in the southern waters.[10] Agreement was made between the British Discovery Committee and the Association of Norwegian Whaling Companies that while the *Discovery* expedition studied the whales around the islands in the southern seas from which whaling operations are carried on the Norwegians should study the whales in Davis Strait and the Norwegian Sea. These studies have shown that the animals that form the food of the whales occur along the edges of the continental shelf and on the banks in the polar seas, not in the deep sea beyond.[11] The plankton develops in masses when the warm saline water enters the cold water at the edge of the continental shelf and on the banks. So far the *Discovery* researches indicate that the South Georgia whales—blue, fin, and humpback – feed exclusively upon one organism, a shrimp-like creature (*Euphausia superba*), the *krill* of the Norwegians.

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[10] See A. C. Hardy: The Work of the Royal Research Ship "Discovery" in the Dependencies of the Falkland Islands, *Geogr. Journ.*, Vol. 72, 1928, pp. 209–234; also reports in *Nature*, Vol. 118, 1926, pp. 628–632, and Vol. 121, 1928, pp. 795–799.

In furtherance of the study of distribution Consul Lars Christensen of Sandefjord, in the beginning of 1927, sent one of his whaling vessels, the *Odd I*, from the South Shetlands westward to Peter I Island and, in 1927–1928, an expedition in the *Norvegia* (285 tons register) to seek new areas for whale hunting and for scientific study. The expedition landed on Bouvet Island, which was annexed for Norway, and worked here for a month. Thereafter it continued southward to the ice border and westward to South Georgia, where the cruise had to be discontinued for repairs to the ship as a result of running aground at Bouvet Island. Two naturalists of the *Norvegia* continued their studies on South Georgia till the end of the season in the middle of March; two other naturalists from Norway joined the expedition here, having earlier worked in the South Shetlands. During the season of 1928–1929 the *Norvegia* has been on an expedition to Bouvet Island, the South Shetlands, and Peter I Island, which was annexed. Thence the expedition proceeded to 59° 40′ S. and 141° W., and on the return to the South Shetlands, looked in vain for Dougherty Island, reported by Dougherty, Stannard, Keates, and Swain.

The Norwegian whaling towns also are making scientific collections. Tönsberg has a polar museum, and since 1917 the Whaling Museum of Commander C. Christensen has been installed in Sandefjord. While the whalers use the charts of the British Admiralty compiled and corrected from the latest information in the Hydrographic Office, latterly Norwegian maps are available for certain areas—maps compiled for the Whalers' Mutual Insurance Association and edited by Commander Christensen's Whaling Museum on the basis of all existing material supplemented by reports and information from the whalers. The Whalers' Mutual Insurance Association was established in Sandefjord in 1911, and the office of the Association of Norwegian Whaling Companies in 1912.[12] Their periodical, the *Norwegian Whaling Gazette*, is edited with the same reliability as the earlier American *Whalemen's Shipping List* in New Bedford (1843–1914).

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[11] Johan Hjort and J. T. Ruud: Whaling and Fishing in the North Atlantic. *Rapports et Procès-verbaux, Conseil Int'l. pour l'Exploration de la Mer*, Vol. 56, Copenhagen, 1929. (In preparation.)

[12] In May, 1929, it became the Association of Whaling Companies, including both Norwegian and foreign companies.

THE ITALIAN COLONIES

Giotto Dainelli
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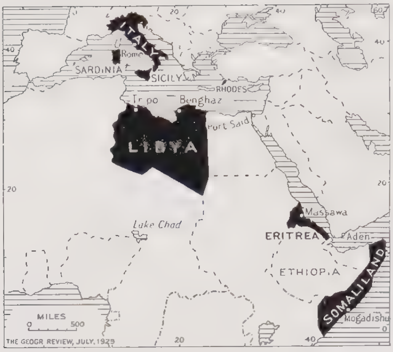

FIG. 1—The Italian Colonies.

NATIONAL economic problems, accentuated since the end of the World War, have stimulated among the Italians the growth of what might be called a colonial conscience. On the one hand we have the rising standard of living among laboring classes, the unforeseen and serious curtailment of emigration, added to a population already very dense and with an increasingly rapid rate of growth; on the other hand we have the decline in the value of the lira, the very moderate per capita wealth of the nation, the insufficiency of agricultural production, and the almost total lack of raw materials necessary for industrial life.

Thus has arisen the renewed impetus given to the construction of artificial reservoirs for the production of electric energy to relieve our dependence on foreign coal.[1] Similarly attempts are being made to improve the cereal cultivation of the home fields, and an extensive program of land reclamation has been inaugurated which ought, in the course of a few years, to put in production lands heretofore waste. Methodical researches are also being undertaken into the mineral resources, and the work of propaganda abroad has in view competition with other nations in the marketing of manufactures. Of a piece with these is the aid given to the mercantile marine both as regards passenger and goods traffic.

There enters into this program also the exploitation of the colonial possessions. The first stage in the development of the Italian colonies—the long first period of acquisition and pacification—has been concluded. This has been a matter of government action and has had little interest for the citizens at large. A number of geographers and naturalists had already turned their attention to the colonies, but the public was generally ignorant of their studies. Today the situation is changed: a new period has begun—that of exploitation. Here it is well to present in outline the existing knowledge of our colonies.

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[1] W. O. Blanchard: White Coal in Italian Industry, *Geogr. Rev.*, Vol. 18, 1928, pp. 261–273.

There is available today quite a large body of information on the Italian colonies. Regarding it two observations may be made. In the first instance the field studies have been made primarily not so much by geographers as by naturalists and especially by geologists. In the second instance the greater number of workers have come from the city of Florence, in which still survives the ancient and famous tradition of naturalists and travelers.

The state also has contributed to the progress of colonial research, especially in its surveys. There exist good large-scale maps of the greater part of the territory of Eritrea and the coastal zone of Libya; for the remainder of these two colonies and for Somalia there are, however, only general maps or original traverses which are waiting compilation. But, broadly speaking, we already have available enough cartographic material to serve as a basis for generalized distributional studies. On the natural vegetation, the indigenous culture, on the possibility of the introduction of plants of industrial value, and on related climatic conditions, data have been gathered by the state agricultural offices. Mention too should be made of the censuses of population and agriculture taken by the government of Eritrea; for Somalia and Libya at the present time there exist only estimates or enumerations more limited regionally.

The principal field studies may now be briefly indicated. For Eritrea—but only for a limited part of it—a first geological study was carried out by L. Baldacci.[2] Later work was done by G. Dainelli and O. Marinelli,[3] who carried out not only a geological survey of a very large part of the territory but also more extended studies of a geographical nature, including the volcanic phenomena, the morphological complex, with special attention to the great depression of Dancalia; contributions towards the geological history of the Red Sea and of East Africa; observations on climate and the climatic zones; and ethnographical studies, including investigation of the ruins of the Axumite period. Along with them L. Loria and A. Mochi (also of Florence) made rich ethnographical collections[4] and gathered anthropometric data. Subsequently the main contribution to our knowledge of this colony was made by P. Vinassa de Regny with a geological study of a part of coastal Dancalia.[5]

Scientific studies of Italian Somaliland—southern as well as northern—are due almost exclusively to G. Stefanini (of Florence): he completed the geological survey of a large part of that colony with results of a most novel character;[6] he has given us also an effective picture of its morphology and in particular of its hydrography.[7] Among his successors, G. Paoli and N. Puccioni (of Florence)[8] respectively devoted themselves to biological and anthropological investigations.

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[2] Osservazioni fatte nella Colonia Eritrea, *Mem. Descr. Carta Geol. Italia*, Vol. 4, 1891, Rome. See also the bibliography by Giuseppe Stefanini and Carlo de Stefani: Bibliographie des travaux des géologues italiens sur l'Afrique, *Comptes Rendus Congrès Géol. Internatl. XIII (en Belgique, 1922)*, fasc. 2, Liége, 1925, pp. 1073–1086.

[3] Giotto Dainelli and Olinto Marinelli: Cenni sommarii sopra i risultati scientifici di un viaggio nella Colonia Eritrea, *Atti VI Congr. Geogr. Italiano*, Vol. 2, Venice, 1908, pp. 212–237. *Idem:* Risultati scientifici di un viaggio nella Colonia Eritrea, Florence, 1912.

[4] The collection is in the Ethnographical Museum of Florence.

[5] Paolo Vinassa de Regny: Dancalia, Rome, 1923.

Libya—as it was nearer to Italy and was conquered during a period in which interest in colonial problems was beginning to be felt—has provoked more intense researches, although these have been limited almost entirely to the coastal zone. Only a short time after the occupation a governmental mission, and another sent out by a special committee from Florence, carried out careful work in almost the whole of the northern zone of Tripolitania between the first plateaus and the sea. The geologist of the first mission was C. F. Parona,[9] and of the second A. Stella; but around them and acting in coöperation with them was a body of workers, for the most part botanists and agricultural experts, inasmuch as the principal objective of the two missions was the study of agricultural possibilities in the new colonial territory.

For Cyrenaica, as is well known, there exists a geological study by J. W. Gregory;[10] a later study by G. Feruglio[11] is devoted to karst phenomena, but—independent of minor studies of local character, among which perhaps the most interesting is one on the geology and morphology of the environs of Tobruk carried on by C. Migliorini[12] (of Florence)—there is available a monographic description by O. Marinelli, G. Stefanini, and E. Ricci.[13]

Of interior Libya, at the present time we know little that is based on scientific research; solely, it might be said, for the recently pacified oasis of Jaghbub, which has been studied by A. Desio (of Florence).[14]

Thus, notwithstanding the gaps which still remain, the scientific exploration of our Italian colonies has progressed far enough to serve as a basis for works of a practical nature, which here and there have been initiated, particularly in Somalia where the great example has been given by His Royal Highness the Duke of the Abruzzi.

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[6] Giuseppe Stefanini: Osservazioni geologiche nella Somalia italiana meridionale, *Boll. Soc. Geol Italiana*, Vol. 32, Rome, 1913, pp. 398–400.

[7] Missione Stefanini-Paoli: Ricerche idrogeologiche, botaniche ed entomologiche fatte nella Somalia italiana meridionale (1913), Florence, 1916.

[8] Giuseppe Stefanini and Nello Puccioni: Notizie preliminari sui principali risultati della Missione della Reale Società Geografica in Somalia (1924), *Boll. Reale Soc. Geogr. Italiana*, Ser. 6, Vol. 3, 1926, pp. 12–76.

[9] Ministero delle Colonie: La Tripolitania Settentrionale, Rome, 1913.

[10] J. W. Gregory: The Geology of Cyrenaica, *Quart. Journ. Geol. Soc. of London*, Vol. 67, 1910, pp. 572–615. *Idem:* Cyrenaica, *Geogr. Journ.*, Vol. 47, 1916, pp. 321–345.

[11] G. Feruglio: I fenomeni carsici della Cirenaica, *Mondo Sotterr.*, Vol. 7, Udine, 1912. See also F. Mühlhofer: Cyrenaika, Vienna, 1923.

[12] C. I. Migliorini: Sulla geologia dei dintòrni di Tobruk, *Atti Reale Accad. dei Lincei*, Ser. 5, *Rendiconti, Cl. di fis., mat. e nat.*, Vol. 23, Rome, 1914, pp. 833–839.

[13] Olinto Marinelli, edit.: La Cirenaica: geografica, economica, politica, Milan, 1922.

[14] Ardito Desio: Notizie geologiche e geografiche sull' Oasi de Giarabùb e sul Deserto Libico, *Boll. Reale Soc. Geogr. Italiana*, Ser. 6, Vol. 4, 1927, pp. 115–145 and 227–255. *Idem:* La morfologia; la geologia (Risultati scientifici della Missione alla Oasi di Giarabùb (1926–1927)), *Memorie Reale Soc. Geogr. Italiana*, 1928, pp. 1–163.

The Physical Bases: Relief

We cannot compare any of our colonies to the French possessions of Mediterranean Africa as regards relief. From Tunisia, through Algeria to Morocco, there runs parallel to the sea the chain of the Atlas, a true mountain chain belonging tectonically to southern Europe. Very different is the mountainous relief of the whole remainder of Africa. If we except the mountains which extend from the plain of Dancalia to the zone of the great equatorial lakes and betray their volcanic nature in their more or less well preserved cones, the African landscape from Egypt to the Cape is uniform, even to the point of monotony. Uplift has produced the series of great plateaus that give the continent its characteristic physiognomy. It is exhibited in Tripolitania, where the rocky plateau of Garian slopes down with a gentle gradient to spread itself out into the desert of the Hammada-el-Homra; and in the plateau of Cyrenaica, which, rising practically straight from the sea, declines gradually towards the steppes farther to the south. Eritrea makes a seeming exception to any one approaching Massawa, where there comes into sight a high mountainous slope cut by wide, deep valleys; but when you climb to the crest you come out at the edge of a vast plateau, the level surface of Asmara. And throughout the whole of Abyssinia, gigantic acropolis of East Africa, there extends the plateau, here more and here less elevated as if it had been cut into immense terraces; and the mountains themselves, that is to say the fragmented borders—only details of the landscape but yet distinguished in its infinite uniformity—have themselves flat-topped summits. And beyond Shoa the Abyssinian plateau descends by great terraces towards the Indian Ocean, the last of these spreading out gently to the alluvial plains of the Webi Shebeli and the Juba in Italian Somalia. Thus arises the similarity of the topography in our African colonies: the differences lie in the altitudes to which successive plateau blocks rise above one another—a few hundreds of meters in Libya and Somalia and some thousands of meters in Eritrea. The more elevated the relief the more intense naturally the work of the rivers. In Eritrea alone does stream erosion notably affect the landscape.

In Somalia and in Libya—where the uplift was not so great and took place at a later date—the terrain is geologically more youthful. In Libya the rock formations, at least in the coastal zone which is best known, are of Tertiary age; with, in Tripolitania, an outcropping of younger Secondaries. In Somalia the rocky plateau which inclines towards the coastal plains is composed in its greater part of strata entirely of Secondary age, although old crystallines also outcrop. In Eritrea, where the uplift has been very much more intense, the whole plateau is constituted of this basement of ancient crystalline rocks on which rest Secondary strata. Moreover, in Eritrea geological conditions are particularly complicated by the great extension and thick-

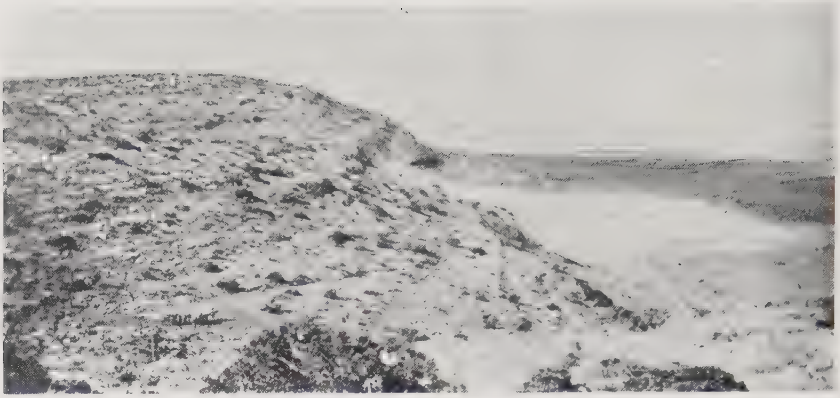

FIG. 2

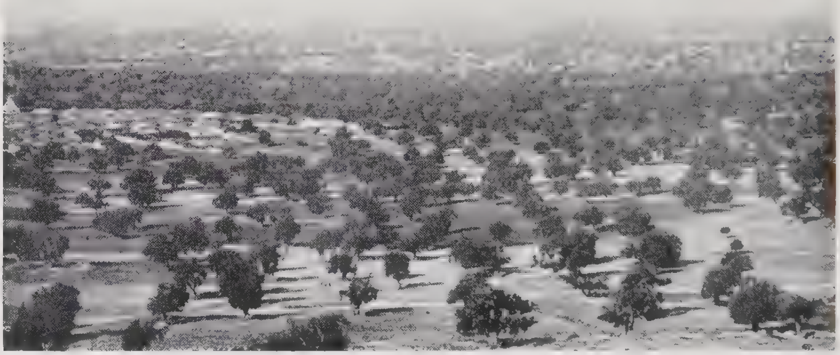

FIG. 3

FIG. 4

FIG. 2—The scarp of the plateau which rises abruptly from the sea, Cyrenaica.
FIG. 3—Olive cultivation, Msellata, Tripolitania.
FIG. 4—Grassy steppe, Tripolitania.

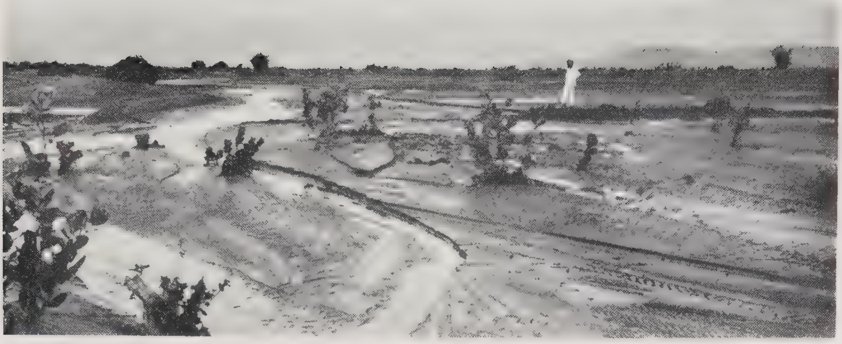

FIG. 5

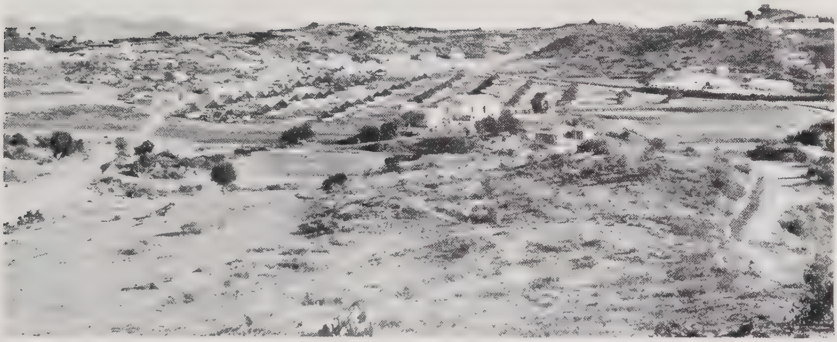

FIG. 6

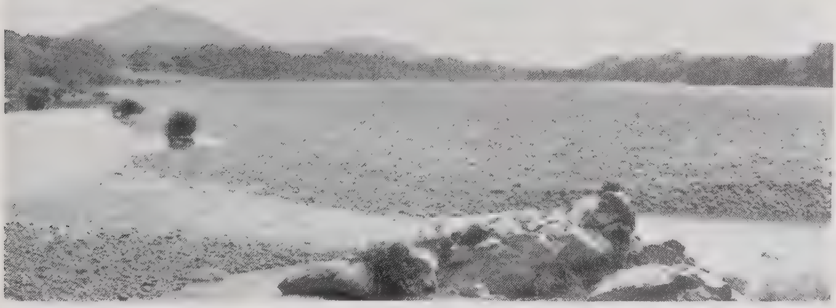

FIG. 7

FIG. 5—The coast plain, Eritrea.
FIG. 6—The plateau, Eritrea.
FIG. 7—The Setit River, here forming the boundary between Eritrea and Abyssinia.

ness of volcanic material both old and recent; while in Libya and Somalia evidences of similar eruptive phenomena are rare and limited.

CLIMATES AND WATER RESOURCES COMPARED

More effective in diversifying the landscape of our colonies is the difference in climate from one to another. The coastal border of Libya has a typically Mediterranean climate. In winter the prevailing south winds tend to preserve warmth; in summer the prevailing north winds to prevent excessive heat. The mean temperature, approximately 20° C., is not unlike that of the greater part of southern Italy itself, with the exception that the diurnal range is fairly constant in the neighborhood of 7° throughout the year, whereas in Sicily it is much greater in summer and less in winter. Also the mean humidity in the coastal zone of Libya is approximately equal to that of Sicily; but, while in the latter it gets very low in summer, in the former it remains fairly high, provoking a very abundant formation of dew with a direct advantage to vegetation since in a certain measure it takes the place of the rains which are not plentiful and are concentrated in the winter period. Thus in comparison with Sicily coastal Libya presents certain advantages as regards agriculture. In Tripolitania in the steppe zone behind the coastal oasis the mean temperature rises, the diurnal range increases, and rains tend to diminish. These characteristics are accentuated the farther one goes into the interior except for a break corresponding to the edge of the Garian plateau; beyond this point one passes rapidly to climatic conditions more and more characteristic of the belt of African deserts.

The same transition from one climate to another is found in Cyrenaica with this difference, that between the seashore and the plateau escarpment the intermediate steppe zone is lacking. Transition is much more rapid; and, furthermore, the nearness of the plateau to the sea results in heavier precipitation, which is reflected in the vegetation; brush and thicket have a notable extension here although they are unknown on the Tripolitanian plateau. The topographic difference between the two colonies also has its effect on the hydrographic régime. The plateaus as a whole are of limestone rock. In Cyrenaica proximity to the sea results in the issuance of the subterranean waters near the base of the rocky escarpment in the form of springs of considerable flow. In Tripolitania, on the other hand, the aquiferous layer presumably passes under the superficial covering of the steppe zone as far as the coastal oases. As this layer approaches the coast it nears the surface until it becomes of such slight depth that arboreal vegetation reaches it with its roots and men reach it primitively with their wells.

Italian Somalia is characterized by a dry hot climate. It falls under the direct influence of the monsoon régime from the southwest during the summer and from the northeast during the winter; there are two intermediate periods of calms with which coincide the rainy seasons. The latitude justifies a mean temperature on the seacoast much higher than in Libya—between 25° and 27° C.—but as one goes toward the interior, it rises notably; nor is the moderating influence of high altitude felt within the limits of the colony. Oscillations of temperature are not great, but the humidity is high, especially on the seaboard, which increases the sensible temperature. The rainfall, scant in the coastal fringe, increases towards the interior, though naturally it is much greater westward; for the colony fortunately is part of an extensive region which has its limits in the mountains of

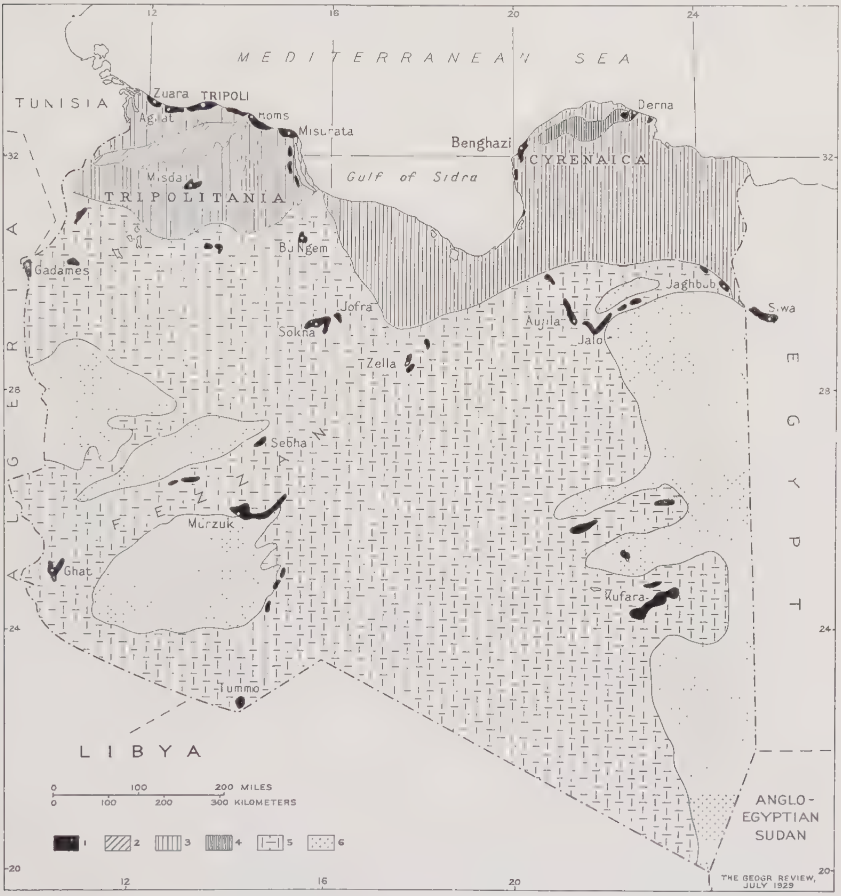

FIG. 8—Map of Libya (Tripolitania and Cyrenaica). The numbers have reference: 1, cultivated land for the most part under irrigation, with palm groves, fruit groves, truck farming (gardens in the littoral zone, oases in the interior); 2, primarily dry farming, olives and figs, locally barley; 3, steppes and *macchia* scrub exploited as pasture, local barley cultivation; 4, woods and dense *macchia* growth; 5, rocky desert (*hammada*); pebbly desert (*serir*); 6, sandy desert (*edeien*). Scale 1:14,000,000.

Arusi and Harar, rising more than 3000 meters. Hence the hydrographic régime is only to a very small degree dependent upon the local climate. It is this high zone lying outside of Italian Somalia which contributes its abundant waters from the territory of Mijertini in the north to the recently acquired territory known as Trans-Juba in the south. Greatest and best known are the Juba and the Webi Shebeli; the former with a flow of about 800 cubic meters per second near Bardera, the second with 200 cubic meters near Afgoi.

While the volume of these streams is seriously diminished by the intense evaporation of the plains and their broad-spreading channels, nevertheless the Juba is navigable from its mouth to Bardera; and it might without great cost or difficulty be improved and rendered navigable over a longer distance. However that may be, the two rivers constitute the true wealth of the colony by permitting the construction of irrigation works on a great scale.

The same plain, moreover, whether through seepage from the rivers or directly from the rains, has a water table reached by the old wells dug by the natives; and a first investigation has already revealed that it overlies a deeper level of artesian water towards the interior.

Conditions in Eritrea appear more complicated. The thermal equator passes approximately through Massawa; but, if here and along the coast as a whole there are characteristic temperatures of 45° to 50°, beginning a short distance from the seaboard the temperature sensibly diminishes until on the margins of the plateau and for the greater part of its extent the mean temperature in general is lower than 20°, although with very marked diurnal oscillations. There is thus a pronounced and rapid transition between the intense periodic heat along the coast and the moderate, eternal spring-like climate of the plateau. The plateau, however, slopes towards the west down to the Sudanese plains where the maximum temperature values are similar to those on the coast, while the minimum values are lower and the air is much drier so that the heat is more endurable.

The plateau also constitutes a boundary between regions with opposite types of rainfall. On the west there are found rains of a tropical régime characterized by violent and brief downfalls and divided into a spring period of little rains and a summer period of great rains, the total not usually exceeding 500 millimeters a year. From the east, that is from the Red Sea, come winter rains, less abundant but gentler and in virtue of that quality possibly more valuable. They increase in intensity from the low coastal plain to the upper edge of the plateau; and here where the two opposing régimes meet there is a marginal zone benefited from both alike. On the plateau, moreover, the low morning temperatures produce such a heavy dew that the roofs actually drip; and from the low coastal plain there rise currents of air laden with moisture which at about

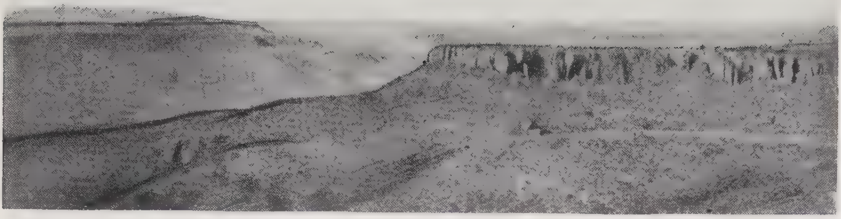

FIG. 9

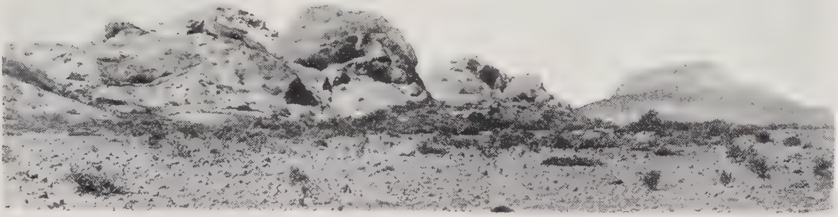

FIG. 10

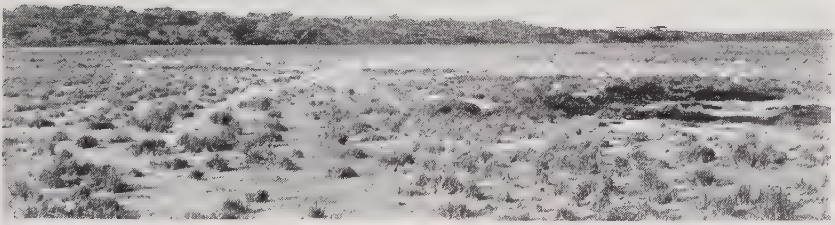

FIG. 11

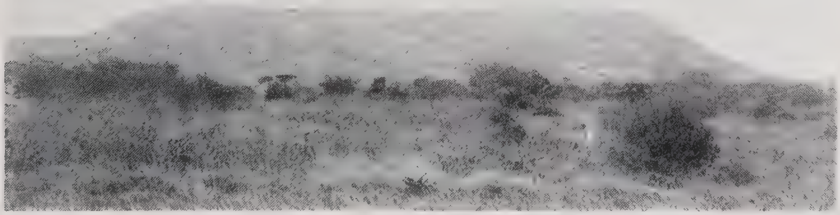

FIG. 12

FIG. 9—The Eritrean plateau, basalt overlying granite.

FIG. 10—The Ambe of Senafè and the Ambe Terica in southern Eritrea. The former is trachyte, the latter is basalt. The isolated relief of the plateau *(ambe)* is constituted by eruptive rocks.

FIG. 11—The alluvial lowland, Somalia.

FIG. 12—Interior terrace, Somalia.

1500 meters altitude cause the daily formation of fine clouds to which is due the locally vigorous arboreal and shrub-like vegetation along a belt not far below the rim of the plateau.

In spite of these comparatively favorable conditions, the Eritrean plateau appears poor in water because the rains rapidly penetrate the ground; nor do they reappear in the form of springs on the plateau. Springs, however, feed nearly all the valleys facing the Sudan and the Red Sea, constituting rivers some of which—like the Gash and the Setit on the southwestern borders—have considerable and even very great flow at the time of the rains. In their lower courses the rivers become impoverished, in some cases disappearing altogether at the surface, though forming a continuous water level in the alluvial or sandy plain which extends from the base of the escarpment of the plateau in the Sudan and along the shore of the Red Sea.

FIG. 13—The Juba River, Somalia.

Each of our African colonies thus has its particular climatic and hydrographic character. And in each the problem of the water supply, essential in agricultural development, has to be solved as it comes up. It is simplest in Libya since there all that is necessary is the raising of water from the subterranean water table between the base of the plateau and the sea without allowing it to go to waste. To extend to the whole steppe zone the culture hitherto limited to the coastal gardens does not offer difficulties, provided capital is available. No great amount of capital is necessary, and it may be raised bit by bit as the area newly taken over for cultivation is extended. In Cyrenaica modest irrigation works would be possible such as are not unknown to the natives for utilizing the principal springs. In Somalia again the problem does not seem difficult, inasmuch as there is no lack of water to be derived from the great rivers; the solution, however, would need organization of works for providing irrigation on a large scale; wells could be used locally; and artesian water might be sought.

In Eritrea the problem is more complex. While on the plateau benefits proportionate to the effort could not be gained at moderate cost, in the valleys small dams could be easily built. On the marginal plains the solution would seem to be found in damming the mouth of each valley that is incised in the upland slopes and in regulating the dams in such a way that the water, after its use for irrigation, could again feed the subterranean water table rather than lose itself in the sea or farther out in the sandy plains of the Sudan.

FIG. 14—The Webi Shebeli at Afgoi, Somalia.

THE VALUE OF THE COLONIES

A colonial region can be viewed primarily according to its productivity in minerals and its agricultural value. Secondly, a colony represents for the mother country a region to which either its surplus inhabitants or its surplus industrial products may be sent or both together. The possibility of mineral development presupposes a particular constitution of the ground; other conditions more or less favor or interfere with exploitation but are not essential factors. Agricultural productivity is also governed by the nature of the soil but more particularly by the climate and the water supply. Settlement—and by this is meant settlement by white people—requires, in addition to agricultural productivity of some sort, special climatic conditions and also a sufficient capacity for population.

As regards possible mineral development it is known that the three Italian colonies do not offer great hopes. However, Eritrea should be distinguished from Somalia and Libya. The whole massive block constituting the Abyssinian plateau is of very considerable geologic age and has been subjected more intensely to the tectonic processes that lead to mineralization. Indeed, there exist on the Eritrean plateau numerous veins of gold-bearing quartz and various copper-bearing and iron-bearing outcrops which are well worth further investigation. In the other two colonies, on the contrary, and in certain low hot zones in Eritrea (in Dancalia) the known mineral deposits are limited almost exclusively to superficial accumulations of salts favored by the hot and dry climate and the hydrographic conditions (closed basins of the coastal lagoons). However, search should be prosecuted for petroleum, certain indications of which have been noted near Massawa, for instance; and for phosphates, whose existence in Libya it is no longer possible to deny.

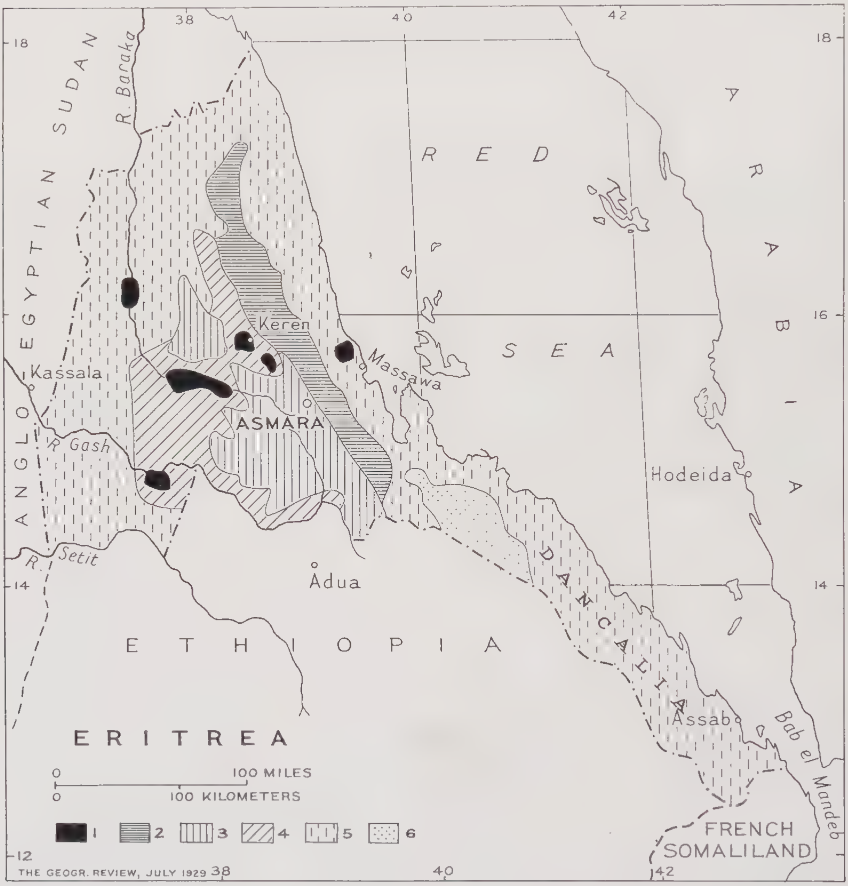

FIG. 15—Map of Eritrea. The numbers have reference: 1, principal areas under irrigated cultivation by settlers; 2, woods and pasture lands, durra cultivation, areas adapted to dry farming by settlers; 3, pasture land (with olive trees, juniper, and *Euphorbia candelabrum*), woods, and cereal cultivation on the plateau; 4, area of the interior valleys—acacia steppes, cultivable valley floors; 5, steppes and thorn forest in which acacias predominate; 6, desert. Scale approximately 1 : 6,000,000.

The economic development of our three colonies must be principally agricultural, though it cannot be everywhere equal. In Tripolitania, in the vicinity of the coast, intensive garden cultivation of an industrial plant, henna, prevails. For the rest there are tree crops, fundamentally the date; with which are associated citrus fruits, the almond, pomegranate, carob, mulberry and, particularly in the least irrigated parts, the olive and non-arboreal crops, greens, potatoes, forage, and grains. In the neighboring steppe zone, which lies between the coastal gardens and the foot of the plateau, barley and wheat alternate extensively with pasturage; and in the marginal zone and the plateau, within limited gardens and their orchards similar to those along the coast, there extends the great arboreal cultivation based on the olive and fig, with barley and wheat. What a difference there is—arising out of the special natural conditions already indicated

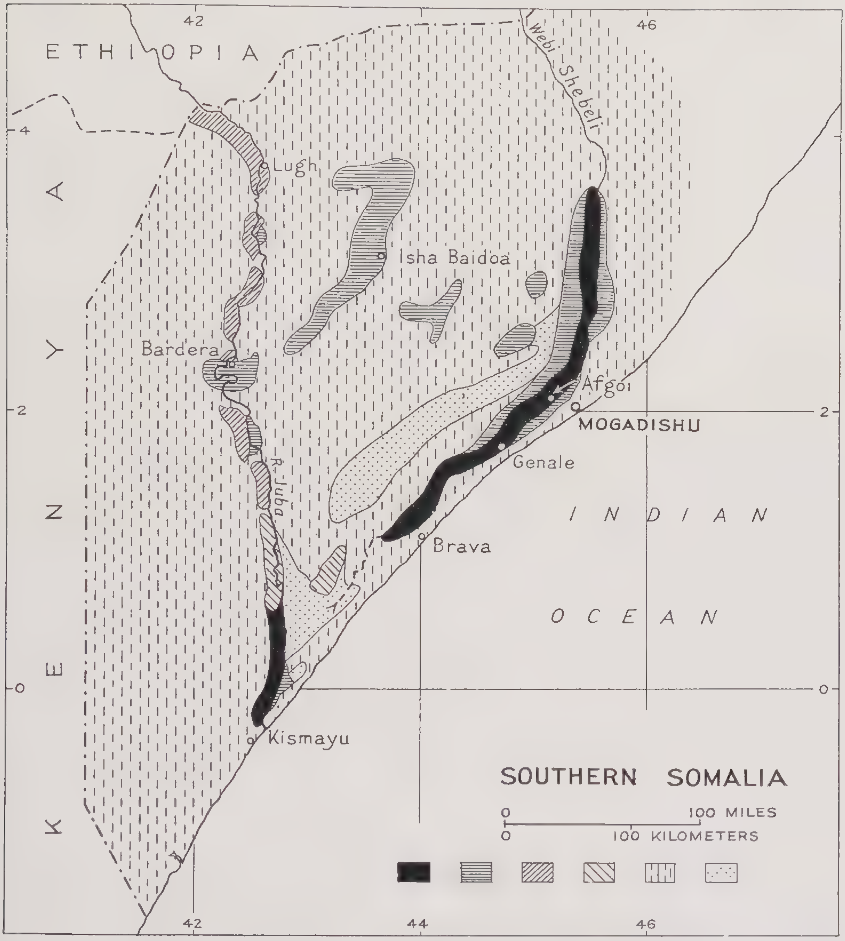

FIG. 16—Map of Southern Somalia. The solid black tint represents irrigated land for cultivation by settlers; horizontal ruling, durra cultivation; close diagonal ruling, gallery forest, for the most part palm groves; open diagonal ruling, gallery forest, for the most part sycamores and tamarinds; vertical ruling, woody steppes used in part for pasture; stipple, prevailing grassy steppe used for pasture.

Northern Somalia is not shown, for data are lacking. Steppes and thorn forests prevail, and there are local tracts of grassy steppe and lands in durra. Scale approximately 1 : 6,000,000.

—in the character of the agriculture of Cyrenaica! Here, indeed, the cultivation of barley prevails: it is already exported in considerable quantities. Finally, Libya,—and we refer more especially to Tripolitania—alike through its climate and through its agricultural character, has many analogies with southern Italy, Sicily and Apulia in particular. It is not territory adapted to a typical commercial agriculture: but its garden and drier crop cultivations between the sea and the marginal fringe of the plateau may be extended.

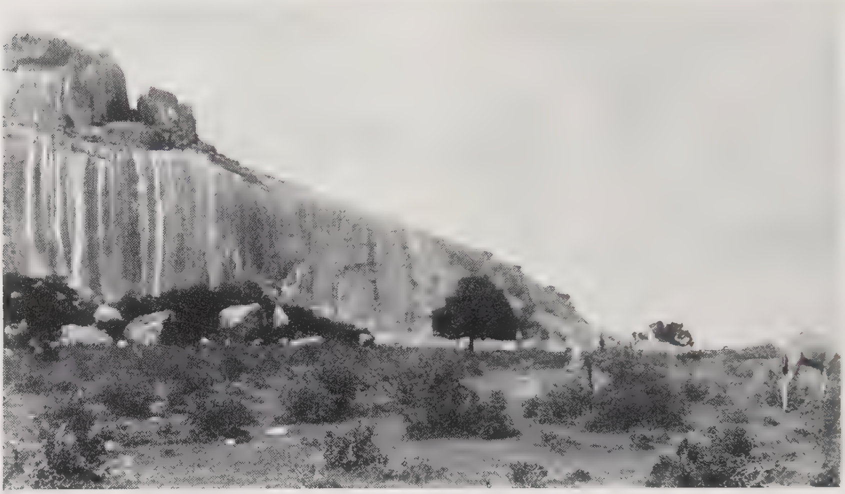

FIG. 17—A *bur*, isolated hill of crystalline rock, Somalia.

White colonization would also be possible from the climatic point of view on the Eritrean plateau; but here there is already an agricultural population proud of its proprietary rights and endowed with a degree of civilization far from low. Cultivation, on the other hand, is not of an industrial nature. Any attempt to substitute on a large scale white agriculturists and white proprietors for the natives would be a serious mistake. But when one descends from the plateaus through the valleys carved out in the escarpment facing the coastal plains or the Sudan, one passes into a more typical tropical zone. And here we find also characteristic plants, many of which offer in their fruits or their fibers or their juices the raw material of industry. The same species besides many others, gums and aromatic plants, are found in the forests or in the scrub growths of Somalia. In Somalia as a whole and the lower zone of Eritrea colonial Italy guarantees the metropole an economic support neither insignificant nor meager. In addition to the climate necessary for the cultivation of industrial plants there is also the possibility of irrigation, most important of all for cotton. There have been attempts at exploitation which have proved unsuccessful, but they can be ignored: they failed because they were not supported by adequate means or by the indispensable scientific and experimental preparation. It is sufficient to consider two undertakings in Somalia, to which reference has already been made, the government enterprise at Genale and that at Shidli due to His Royal Highness the Duke of the Abruzzi, to be convinced that a prosperous future may be looked forward to for both of these colonies but particularly for Somalia. On the other hand, it is useless to cherish the illusion that there may be found between the Red Sea and the Indian Ocean an outlet for the superabundant population of Italy. These regions can support several hundreds or possibly thousands of whites but only in a supervisory capacity on the plantations.

FIG. 18—Scene around a well, Somalia.

Of the three colonies, Eritrea in the last analysis occupies a somewhat special place. This plateau is nothing more than an outlier of the immense Ethiopian plateau. And the latter, an independent political unit, densely inhabited by people of no inconsiderable civilization and of notable economic possibilities, is a potential outlet for Italian industries. A port and a railway connecting it with the plateau are already in existence: what is needed is the perfecting and extending of roads as lines of penetration.

Thus the three Italian colonies have aspects that differentiate them one from another. If the future of Somalia lies particularly in the development of industrial agriculture and that of Eritrea principally in its position as a commercial zone of transition towards the whole Ethiopian region and also towards Arabia, the importance of Libya remains principally political, assuring that equilibrium among the Mediterranean powers which Italy, the most Mediterranean of them all, has built up for safeguarding its own independence.

ANCIENT MEDITERRANEAN PLEASURE GARDENS

Ellen Churchill Semple

Noonday in early May on the Isthmus of Corinth. Beneath a ledge of gray limestone a ribbon of mauve shadow stretches across the narrow beach to a sapphire sea. A stiff breeze from the Hellespont tips the Aegean waves with curling crests, sucks up the moisture from the lucid air, and sends the limestone dust swirling down the white road. The sun burns face and hands as if its rays came through a lens, while the alkaline dust makes the eyes and skin smart. I creep for refuge into the purple shade beneath the ledge, blessing this "shadow of a great rock in a thirsty land," to eat my Homeric lunch of bread and wine, goat's cheese and figs.

CLIMATE goes far towards explaining those lovely pleasure gardens widely distributed in the ancient Mediterranean lands and still persisting in many places with their traditional features of confining wall or hedge, their seclusion and shade, their flower beds and ornamental fruit trees, their fountains and central pool, their sunken paths and marble seats and colonnades, their statuary and shrubbery, and the vine-grown pergola for the outdoor repast.

The Mediterranean climate encouraged the maintenance of pleasure parks and gardens, because the mild temperatures kept a succession of trees and plants in blossom all year round, brought winter blooms to the rose and almond tree even in northern Italy, and renewed the freshness of the evergreen foliage during the winter rains; hence it rewarded the labor of the cultivator and preserved the beauty of the garden in the cold season. But gardens were the boon of summer. The long, hot, cloudless months made the shelter of vine-grown arbor and cypress avenue a welcome refuge. When the thirsty etesian winds swept down from the north or the sirocco from Africa, only the garden kept moist and green and fresh. Eyes tired by a relentless sun and its reflection from the limestone roads rested gratefully upon the dark foliage of laurel or oleander. When the stifling afternoon passed and the people issued from their darkened houses, the garden paths invited to leisurely strolls. In the Paradise legend Adam and Eve heard "the voice of the Lord God walking in the garden in the cool of the day," after the custom of Palestine and other Mediterranean lands. Likewise Ammon Ra "walked abroad" in his temple garden at Thebes, where Queen Hatshipsut had planted myrrh trees imported from distant Punt.

But other factors, social and economic, contributed to the development of these ancient gardens: early concentration of population in cities, expansion of trade and the accumulation of wealth, stimulation of civilization by commerce, growth of a cultured leisure class, with its concern for the amenities and luxuries of life. A more potent factor still was the rapid advance of agriculture till it attained the aesthetic stage, crowning evidence of its intensive character.

The cultivation of land for the mere embellishment of life is a frequent concomitant of intensive tillage, even when scant arable area makes such use of the soil seem extravagant. It is conspicuous in warm countries, where an open-air life is possible, but appears also in less exuberant form in colder countries that have a long growing season like England. As a native growth it meets us in modern Japan, the Hawaiian Islands, and other islands of the South Seas, in ancient Persia and Babylonia, in Kashmir and northern India under the Mongol rulers, and at the other side of the world in ancient Mexico. All these countries developed intensive agriculture, and all had to rely wholly or in part upon irrigation to secure an adequate food supply.

Ornamental gardening became a feature of ancient Mediterranean civilization. It began at the eastern end of the basin at an early period and advanced westward in the wake of trade and colonization. Everywhere it took root and became the fine efflorescence of that patient, tireless tillage of the region. It grew out of the widespread fruit, flower, and herb culture, which in greater or less degree depended upon summer irrigation. The pleasure gardens originated in walled orchards and vineyards, in plantations of flowering pomegranates, quinces, plums, and apricots, in groves of stately date palms, all with their irrigation pools and canals. The spaces between the rows of trees, for the more economic use of the precious soil, were often planted with flowers at once useful and beautiful, like the saffron-yielding crocus or the edible poppy, or "the henna flowers in the vineyards of Engedi," or the violets, iris, and roses of Boeotia, Cyrenaica, and other lands for the manufacture of perfumes and unguents.

The bloom and fragrance of the grape, pomegranate, and the nut tree were prized by the ancient Jews, as were the fruits. "I went down into the garden of nuts to see the fruits of the valley, and to see whether the vine flourished, and the pomegranates budded." Orchards and vineyards provided certain essential elements of the pleasure garden—blossoms, fragrance, and especially shade. Hence the ancient Mediterranean gardens, in their long development, employed vine-grown trellises, fruit trees, alleys of shade trees, and masses of shrubbery, and relied for artistic effects only in part upon flower beds. Even then they preferred the flowering shrubs, like myrtle, laurel, and oleander, masses of green picked out with pink or white. The aesthetic value of the ripe fruit was never discounted.

In point of size the ancient gardens varied from the ample palace grounds and parks of kings—which, however, reached only moderate

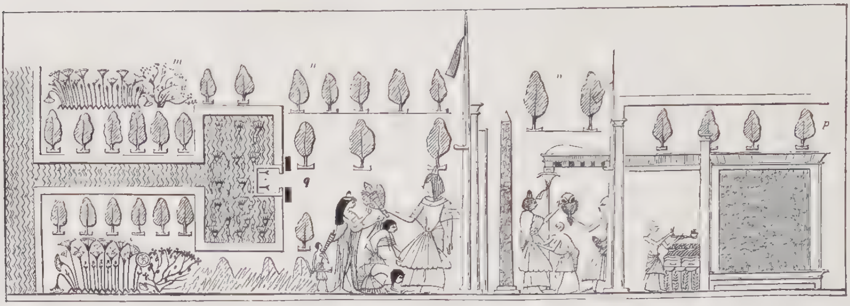

Fig. 1—Theban villa with garden. (After Wilkinson: The Manners and Customs of the Ancient Egyptians, 1847, Vol. 2, Fig. 116, p. 129.)

proportions as a rule—to the private garden, whose size depended on its location and on the means of the owner. In the size of gardens one seems to detect everywhere a certain restraint probably due to the high cost of land and of irrigation. Water theft from the public aqueducts was a common offense among Athenians and even the wealthy landed gentry of the Roman suburbs. The typical private garden was small, even diminutive. It lay near the house and formed an outdoor extension of it; here much of the family life was led. The master could step from drawing-room or dining room to flower-bordered terrace or shaded path. Resting on a marble bench or walking beneath a colonnade, he commanded a view of the whole. Its small size encouraged complete cultivation and ample use of water and did not necessarily lessen its beauty. A little garden dedicated to Eros is made to speak for itself in an anonymous Greek poem: "I am not great among gardens, but I am full of charm."

This small scale was yet further reduced in the exquisite miniature gardens planted in the peristyles of Greek and Roman houses in the century before the Christian era or perhaps earlier. The peristyle garden still survives in the Spanish patio with its arcade, central fountain, myrtles, pomegranates, jasmines, and palms growing in earthern jars. In the eastern Mediterranean it survives also in the spacious court of the typical Damascene residence, whose tessellated floor is broken in the center by water basin and fountain, surrounded by flowering plants. Orange, lemon, and pomegranate trees afford rest to the eyes. The fragrance of jasmine fills the air and penetrates to the recessed colonnade or *liwan*, where couches look out upon the enclosure.

In contrast to the small private gardens were the sacred groves and temple grounds. These also, like the peasant's orchard, felt the transforming touch of the gardener and became beautiful parks. The Temple of Jerusalem was an exception, because the Jews feared that trees in the courtyard might savor of the hilltop groves of Baal.

The summer drought dictated the introduction of water as an

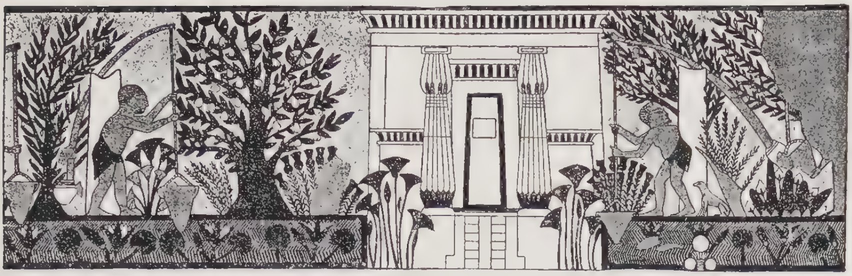

FIG. 2—The garden of Apoui, Thebes. (After Mémoires publiées par les membres de la Mission archeologique française au Caire, Vol. 5, 1894.)

unfailing feature of the garden. It was handled as an artistic motif in countless ways. It was conducted about in stone, cement, or tiled runlets; it emerged from some decorative opening in a terrace wall or issued in jets from a statue; it was collected in fishpond or lotus pool; it flowed from artificial grotto or leaped from a rocky ledge into a marble basin. Moreover, the irrigation canals with their secondary furrows necessitated a regular system, which tended to throw the garden plan into geometric forms. The modern oriental garden always seems dominated by the irrigation scheme on which its life depends. In the exquisite Indian gardens seen about Jaipur and Amritsar the water conduits dictate the basic lines of flower beds, tree plots, and pools, just as they do in the garden plans depicted on ancient Egyptian tombs.

The same thing is true of the Persian rose gardens which in Shiraz today reproduce the ancient garden pattern. An old description of a sixth-century Persian rug shows the design of a pleasure garden, planted in fruit trees and flowers, crossed by straight paths and irrigation conduits, while the border represents long flower beds. Persian garden rugs of 1600 and later show the traditional design—a central water basin with fish and ducks, canals leading thence in formal arrangement, narrow paths along the canals, cypress alleys or slender flower beds in the border, trees and shrubs growing in vases, while the weave in the streams resembles "watered ribbon."[1] The whole arrangement is rectilinear, reproducing the Persian garden plan as necessitated by irrigated horticulture in a semiarid land.

Like their Persian prototypes, the Mediterranean gardens were for the most part formal and architectural in style. They were not an idealized landscape like the English park, or a miniature landscape like the Japanese garden. They had no place for winding paths or pools with the sinuous outlines of natural shores. Back of the garden we see the engineer with his problems of hydraulic pressure, his traditions of durable and economical construction, even when pursuing aims of beauty, and his architectural skill in utilizing the small space at his command.

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[1] See Marie Luise Gothein: Geschichte der Gartenkunst, Vol. 1, Jena, 1914, Fig. 102, p. 150. Volume 1 of this admirable work deals with the development of gardens from ancient Egypt to the Renaissance in Italy, Spain, and Portugal and is richly illustrated. An English edition of the work is now available, New York, 1929.

So much for the general conclusions. A survey of the ancient Mediterranean gardens according to countries will demonstrate the truth of these conclusions and show the types that developed in various regions, owing to local differences of geographic, economic, and social conditions.

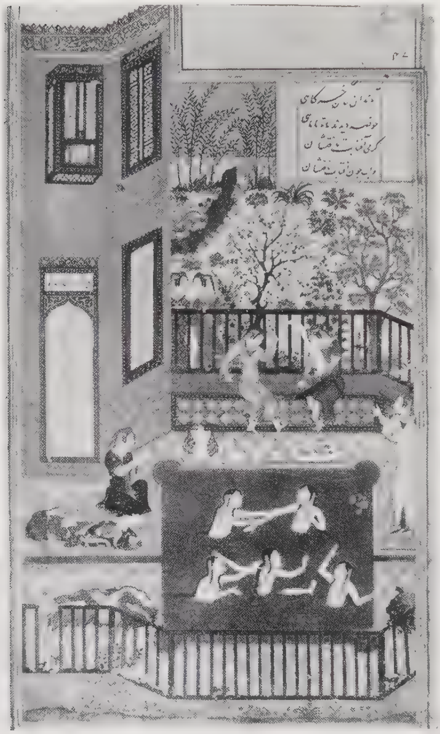

Fig. 3—A Persian garden. (From an early sixteenth-century miniature in the Cochran Collection, Metropolitan Museum of Art, New York.)

Paradise, that garden which "the Lord God planted eastward in Eden," was modeled upon the gardens found in all irrigated lands from Persia to Palestine; and it became a prototype of the flowery retreats of Mediterranean civilization from Damascus, Jerusalem, and Antioch in the East to Spain and Granada in the West. The river that watered Paradise was divided into several channels, after the manner of "the shorn and parcelled Oxus," the Nile, and other irrigation streams. The garden contained "every tree that is pleasant to the sight, and good for food." The tree of knowledge and the tree of life were rare exotics introduced by the early dramatist who staged here the first great tragedy of man.

The desert Arabs, who skirted the high rim of the Mediterranean Basin from Moab to Hermon and looked down on the irrigated gardens of Damascus and Ramoth-Gilead, pictured their paradise as a pleasure garden abounding in fountains of pure water. There in the noonday heat the saints reclined on silken couches spread in deep shade and enjoyed the fruits always ripe on the trees. It was the Garden of Resort in the Koran, the Garden of Eden, the Garden of the Most High with everything to satisfy the taste and delight the eye. "Close down upon them shall be its shadows and lowered over them its fruits to cull." Though the Arab paradise waited for the pen of Mohammed, it belonged of old to the Semites of desert and grassland; it doubtless lived in Arab poetry, ages before the seer of Mecca.

Gardens in Palestine and Syria

The oriental models found apt imitators in Palestine, Philistia, Phoenicia, and northern Syria, where geographic conditions encouraged their introduction and further development and where the rich and powerful maintained large estates; but the Judean peasant enjoyed his leisure beneath his own vine and fig tree or raised a few flowers in his herb garden. King Solomon had his pleasure park near Jerusalem, whither he was wont to go in the morning, Josephus tells us. It was laid out in fine gardens and abounded in rivulets. The author of the Song of Solomon described an ideal garden to which he compared his beloved. A high wall ensured its privacy, and it was watered by a never-failing spring. Almond trees raised their crowns of pale pink blossoms. The scarlet fruit of the pomegranate trees punctured the dark foliage with points of light. There were beds of narcissus, crocus, henna, and all the other aromatic plants that could be made to grow, while the blossoming grapevines gave forth their perfume. "Awake, O north wind; and come, thou south; blow upon my garden that the spices thereof may flow out."

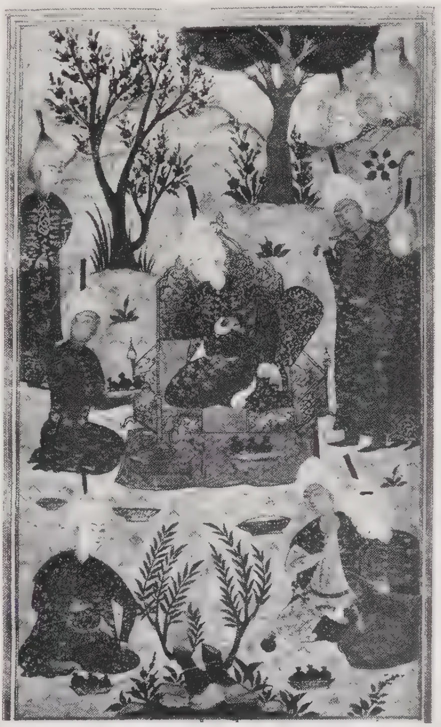

Fig. 4—A Persian garden. (From an early sixteenth-century miniature in the Cochran Collection, Metropolitan Museum of Art, New York.)

The Bible in figurative language indicates the beauty of these gardens, specifies their trees and flowers, and suggests their wide prevalence. The Garden of Eden is the synonym for earthly beauty and productivity. Jehovah, placated after one of the habitual backslidings of His people, promises to convert the desert into a tree garden: "I will plant in the wilderness the cedar, the shittah tree [acacia], and the myrtle, and the oil tree; I will set in the desert the fir tree, and the pine, and the box tree together."

In the Book of Ecclesiasticus, Wisdom compares her glory to the beauties of a garden—to the cedar of Lebanon, to the cypress of Mt. Hermon, to the palm and the olive and the plane, to the wide-spreading terebinth tree, to the blossoming grapevine, and the roses of Jericho.

From her issue pleasant odors like the fragrance of spices and sweet-scented shrubs. She invites all to come and eat of her fruits. Then the figure of speech shifts to another feature of the garden: "I also came out as a stream from a river, and as a conduit into a garden. I said, I will water my garden, and will water abundantly my garden bed; and, lo, my stream became a river, and my river became a sea." So full flow the wellsprings of wisdom.

In the city of Jerusalem the royal rose garden alone was allowed, because no dung might be brought within the walls; outside, practical considerations probably dominated, though the introduction from Greece of laurel, iris, ivy, mint, narcissus, box, and rue indicates an aesthetic motive. Under Greek and Roman rule, when peace brought plenty, the environs of Jerusalem blossomed with gardens, orchards, and olive groves. A wide stretch of these north of the Wall of Agrippa was destroyed by Titus in 71 A. D. during the siege of the city. On this side opened the Gate of Gennat or Garden Gate. East of Jerusalem, on the Mount of Olives, lay the Garden of Gethsemane, much frequented by the citizens. When the April sun ripened the fields of barley and the first blast of the sirocco heralded the Feast of the Passover, thither the men of Jerusalem, escaping from the city's heat, would resort for nightly promenade. One such group of friends, one such night, made this little pleasure park a synonym of agony. Another such garden near the hill of Golgotha received the body of the dead Christ. The ancient Jews used these green enclosures as family burying grounds, in which a natural or artificial cave served for the sepulcher.

Semitic garden technique was early perfected in Syria, because this land, more than Palestine, was constantly subjected to Persian influences, both through trade and conquest. There the imperial rulers established royal parks, where the cedars of Lebanon grew larger and finer than on their native mountains. The palace of the Persian governor of Northern Syria, at the source of the little Dardes River between Aleppo and the Euphrates, had a "beautiful garden containing all that the seasons produce," but it was destroyed by Cyrus the Younger in 401 B. C.

Throughout Syria and Palestine the groves on hilltops, consecrated by the native Semitic population to the worship of Baal and the generative forces of nature, seem to have been improved by cultivation. These groves were sometimes found growing about high-laid springs, which later were distributed into water conduits, or they were planted as acts of devotion near a spring or well. The sacred trees were the oak, tamarisk, poplar, palm, and terebinth, all which were improved or maintained by irrigation. As the groves were gradually provided with altars and finally with temples they became converted into gardens.

The native Canaanites and Phoenicians dedicated these gardens with obscene rites, but the Israelites also frequented them and thereby provoked the denunciations of the prophets. Such probably was the sacred grove and temple of Astarte, located at the springs of the Adonis River (Nahr Ibrahim) below the crest of the Lebanon Mountains. Here the people of Byblus and neighboring Phoenician cities celebrated every spring the death and resurrection of the nature god Adonis, youthful lover of Astarte (Aphrodite). Here the red anemone, dyed in the blood of the slain god, bloomed amid the cedars and walnut trees, and here the mourning worshippers sacrificed the miniature "gardens of Adonis," which figured in his rites as practiced in western Asia, Alexandria, and Greece. They were small baskets or earthern pots planted with wheat, barley, fennel, lettuce, and various flowers; epitomes of field and garden, sprouting and withering in eight days, they typified the ephemeral life of spring vegetation. Adonis worship prevailed also in contaminated Jerusalem, where Ezekiel saw the women wailing for the god in the temple gate. Isaiah describes the short-lived gardens which were placed before the images of Adonis, exactly as one sees them today in the Catholic churches of Italy on Good Friday, the vernal memorial of the dead Christ.

FIG. 5—The Garden of Gethsemane. (Photograph by James Ricalton, courtesy *of American Forests and Forest Life.*)

The Phoenicians were commercial nurserymen in Homeric times. Their cargoes included plants and trees, useful and ornamental, which were disseminated over the whole Mediterranean from their native habitats in the East and early became commodities of general international trade. This process stimulated horticulture, spread information as to methods of cultivation, or led to large-scale experiments in acclimatization. It is possible to follow the introduction of the peach from Persia into Egypt, thence into Rhodes where the tree long sulked and refused to bear, and finally into Greece and Rome.

EGYPTIAN GARDENS

Phoenicia and Palestine, through centuries of commercial and political affiliation with Egypt, drew suggestions for their horticulture also from the Nile Valley. There all conditions encouraged the early development of pleasure gardens—careful agriculture, a long, hot summer and the need of escape from it, demand for flowers in the worship of nature gods like Isis and Osiris, and finally the presence of a rich and refined leisure class. The Egyptian pleasure garden never lost the marks of its origin in orchard and vineyard and of its conformity to the requirements of irrigation.

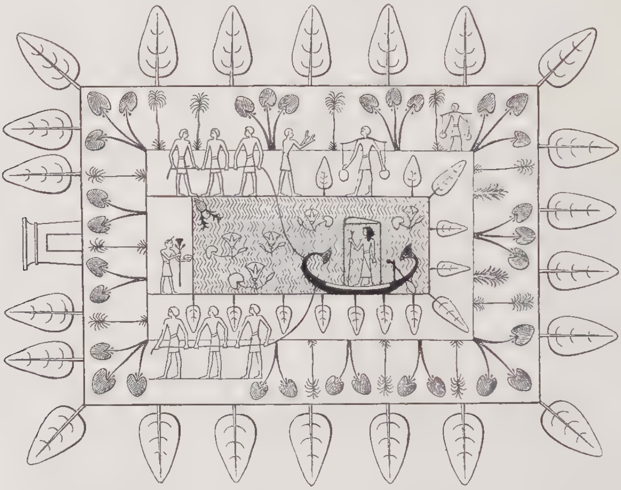

FIG. 6—Painting on a tomb at Thebes. (After Wilkinson: A Popular Account of the Ancient Egyptians, 1871, Vol. 1, Fig. 27, p. 25.)

Formal gardens existed in Egypt in the Fourth Dynasty (2800 B. C.). In the Eighteenth Dynasty garden technique was fully developed and beautified the country and city houses of the wealthy. Local plant resources no longer sufficed; incense trees and other exotics were imported. A garden of this period, depicted at Thebes, shows a walled enclosure laid out in eight sections. The middle section is occupied by a long grape arbor shading a path to the dwelling. Near by are two water basins with pavilions on their margins, lotus flowers floating on their surface, and ducks swimming about. Two other rectangular tanks, bordered by avenues of alternate palms and fig trees, occupy the front part of the garden. An artistic balance marks the composition of the whole.

A picture in a high priest's tomb at Tel-el-Amarna shows a complex of buildings, comprising his residence and the storehouses of the temple, all surrounded by a garden. Trees set in depressions to hold water fill the spaces between the buildings. A palm garden has a square tank or pool in the center, around which other trees are planted in formal lines. A flight of steps leads down to the water, while a kiosk overlooks the pool. This is a recurrent feature in Egyptian gardens. A villa garden depicted on another Theban tomb has the usual combination of canal, water basin, shady avenues, and flower beds but in addition shows an awning stretched over the entrance of the dwelling and projecting into the garden to form an outdoor room.

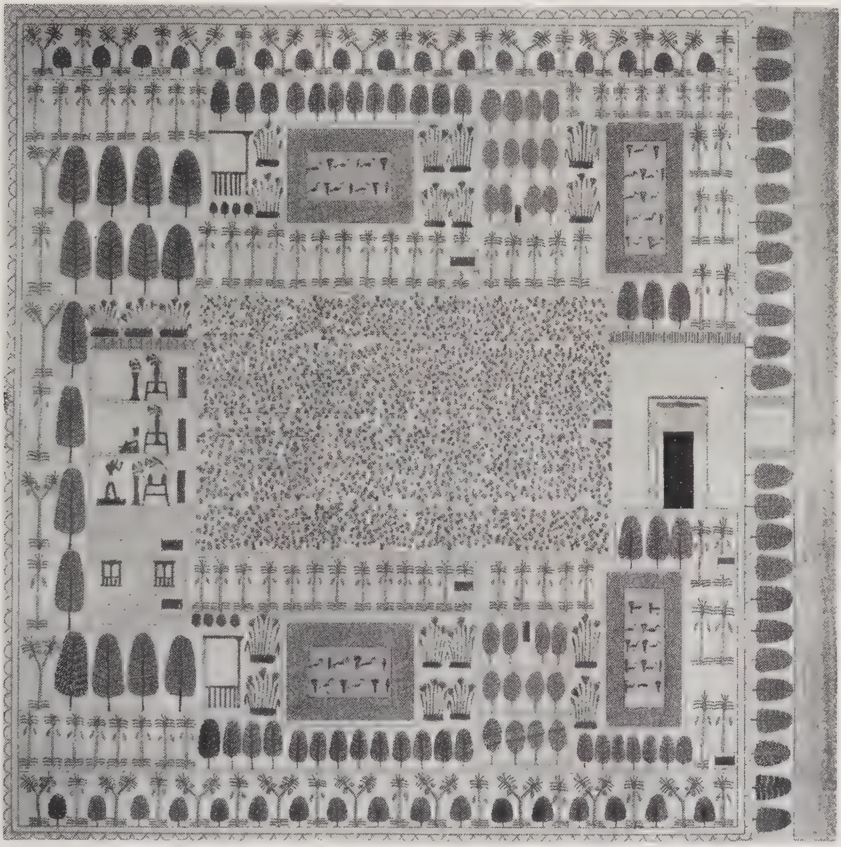

FIG. 7—Painting in a tomb representing the garden of the commander in chief of Amenophis III, Thebes. (After Ippolito Rosellini: I Monumenti dell' Egitto e della Nubia, Monumenti civili, Vol. 2, Pisa, 1834.)

Flowers were used profusely in the social and religious life of the ancient Egyptians. At banquets they decked both table and guests. The guests wore lotus buds in their hair and held out the open blossoms to one another to smell. Garlands festooned the wine jars. Bouquets were offered to the gods; wreaths encircled the necks of sacrificial geese and bulls and covered the mummy cases on their way to the tomb. Finally, according to a love song of the Turin papyrus, a garden is the trysting place of two lovers; and there beneath a wild fig tree they meet "on the festival of the garden." One is reminded inevitably of Japan with its national flower festivals and its passion for gardens.

Greek Gardens

In contrast to the explicit testimony on aesthetic gardens left by Egyptian tombs and papyri, evidence of development of private gardens in Greece is fragmentary and meager till Hellenic culture has passed its zenith: then the references become abundant. The pseudo-Platonic dialogue "Minos" alludes to authoritative books on gardening which have vanished. But there is ample evidence of a highly developed garden technique, which beautified the temple groves with flower beds and fountains and converted prosaic orchards into recreation parks.

The Greeks, like the Hebrews, show a love of gardens in their mythology. As companion piece to the Garden of Eden, they give us the Garden of Hesperides, located in a fabled island of the far west. Pindar describes its beauty:

> There round the Islands of the Blest,
> The Ocean breezes blow,
> And golden flowers are glowing,
> Some on trees of splendor growing
> And some the water feedeth.
> Fair wreaths they yield, wherewith
> The happy ones do twine their hands.

The garden of Alcinous, though planted for practical purposes, reveals a sense of horticultural beauty. "Without the courtyard hard by the door is a large garden covering four acres; around it runs a hedge on either side. Here grow tall thrifty trees—pears, pomegranates, apples with shining fruit, sweet figs, and thrifty olives. On them fruit never fails; it is not gone in winter or in summer but lasts throughout the year. And here trim garden beds, along the outer line, spring up in every kind, and all the year are gay. Near by two fountains rise, one scattering its streams throughout the garden, one bounding by another course beneath the courtyard gate toward the high house."

From such farm gardens developed the Greek pleasure garden. Flowers were raised on all country estates to provide "decorations for altars and statues and wreaths of beauty and fragrance for the person." They were the chief crop in industrial gardens, which supplied the maker of perfumes and unguents. Those in Cyrenaica were famous because the semiarid climate made the roses, violets, and crocuses more fragrant than elsewhere. Such commercial nurseries doubtless stimulated aesthetic horticulture, which was also aided by Alexander's conquest of western Asia; for the victors returned with new fruits like the citron, with new plants, and with countless Semitic slaves trained in garden technique; finally they were filled with enthusiasm for the numerous Persian paradises they had seen.

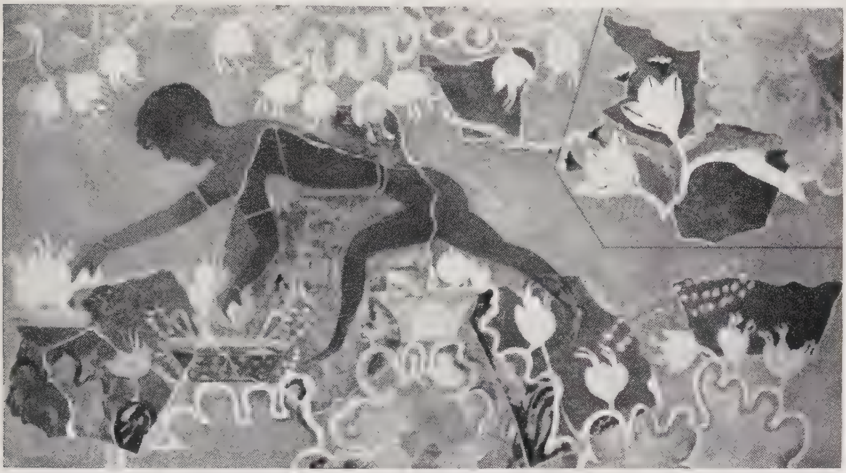

FIG. 8—Mural painting in the palace of Cnossus representing boy gathering crocuses or saffron for a religious ceremony or feast. About 1800 B. C. The original is in the museum at Candia. A reproduction in color appears in Sir Arthur Evans's "The Palace of Minos," Vol. 1, 1921. (This reproduction is from Plate 26 of Rostovtzeff: A History of the Ancient World, Vol. 1: The Orient and Greece, 1926, by permission from the Oxford University Press.)

But Greek gardens had appeared in Athens before this. Aristophanes mentions "fragrant gardens" injured by insects; vine-grown gardens where the birds picked the berries of the myrtle, poppy, and sesame; and sweet violets growing by a fountain in a garden. Such allusions are short and casual, but they indicate quiet green retreats like that Lesbian Garden of the Nymphs described by Sappho (600 B. C.):

Through orchard plots with fragrance crowned
  The clear cool fountain murmuring flows,
And forest trees with rustling sound
  Invite to soft repose.

We hear more of private gardens which were thrown open to the public and therefore figured in the common life. Cimon of Athens, general during the Persian War, pulled down the walls of his garden and grounds in order that his fellow citizens might share the fruit. Plato, Epicurus, and Theophrastus bought land and planted gardens to be used for schools of philosophy, and they came to rank among the glories of Athens.

The architecture of the Greek dwelling, with its open peristyle court, suggested the interior garden as a natural accessory; yet in Homeric times and long afterward this court served as an outdoor workshop. Where or when it first came to be planted and beautified is unknown; for this evanescent art of flower and shrub would leave few traces. Yet the remains at Herculaneum and Pompeii reveal the perfect development of the peristyle garden in Greco-Roman houses of the first and second centuries before the Christian era. Vitruvius describes the Greek drawing-room in the Cyzicene style of house as facing north upon gardens in the rear and having windows like folding doors, so that the garden view might be unobstructed. To this and later periods belonged the perfected house garden of the widespread Greek cities. These were small and exquisite, rigidly symmetrical, and adorned with colonnades and statuary. Shade trees and fountains cooled the air; beds were planted each with a separate kind of flower, lily or rose, violet or crocus, lest the large should rob the small of its nourishment. Gardens by the sea had lagoons and navigable channels, in which grew marine plants, encircled by native trees and shrubbery.

It was in their public parks, however, that the democratic Greeks developed their national talent for landscape gardening. These grew out of the sacred groves, transformed by every means of enhancing natural beauty known to the Greeks, and devoted to popular recreation and exercise. The Academy of Athens, outgrowth of Athene's sacred olive grove in the Cephisus Valley, was repeatedly beautified by tyrants and statesmen of the city. Hipparchus surrounded it with walls in the late sixth century before Christ, and Cimon embellished it with walks, trees, and fountains. Here were alleys of elm and plane, "sunless at noon," nightingales singing in the deep coverts, groves of laurel and olive, narcissus and crocus blooming abundantly beside the irrigation rivulets. Thus Sophocles knew it, as later did Plato and his followers. Gymnasia and palestrae were places not only of training but also of recreation; and their plantations of trees, shaded walks, and fountains attracted young and old. The ground plans of gymnasia excavated at Delphi, Priene, Epidaurus, and Pergamum indicate that landscape gardens occupied the peristyle enclosures. Even prosaic Sparta located its wrestling ground in the Plane-Tree Grove on an island in the Eurotas River.

The sacred groves of forest trees, which antedated temples, were gradually improved by cultivation, diversified by ornamental trees and plants, and adorned with marble altars and fountains; for springs were invariably present, whose nymphs were honored. Fruit trees contributed their beauty and yielded revenue. Strabo says that "flowery groves" surrounded the temples to Artemis, Aphrodite, and the nymphs in the Alpheus Valley about Olympia. Here Xenophon built a temple to Artemis in an orchard. Pindar speaks of the "pleasant garden" surrounding Aphrodite's temple in Cyrene, where the Greek colonists maintained consecrated groves. Finest of all was the Garden of Daphne, sacred to Apollo, near the city of Antioch. It was famous for its laurel and cypress trees, its fountains and streams, and its shining temple of Apollo, whose sumptuous festival was held every August.

A motive for the introduction of flower gardens into the sacred groves lay in the demand for a particular flower in the cult of each deity. Aphrodite was the "violet-crowned" protector of blooming gardens. Sacred to her also were the rose and the bridal myrtle with its fragrant white blossoms. The laurel tree with its clustered bloom, essential in the worship of Apollo, was always planted near his temples. Laurel and myrtle were not native to the Crimean shores of the Euxine; the Greek colonists there tried by every known art to grow them for religious purposes, but in vain. They succeeded in raising figs and pomegranates, whose foliage and fruit graced many a Mediterranean garden, but had to cover the trees in winter.

Greek settlers on distant Mediterranean shores were constantly reclaiming some new spot to beauty. Colonists on the Asia Minor and Syrian coast were doubtless stimulated thereto by contact with the Persians. Tissaphernes, Persian satrap of Lydia during the Peloponnesian War, had a park, "a place charmingly wooded and watered, with delightful walks and summerhouses." Antioch was laid out by Seleucus Nicator on a magnificent scale with boulevards planted in flower gardens, which were bordered by colonnades and ornamented with marble pavilions, baths, and fountains. From the west gate of the city an avenue led through a suburb of garden-set villas, vineyards, rose gardens, and groves to the Park of Daphne. The Ptolemies laid out a succession of fine public gardens in Alexandria about the museum and gymnasium; the latter had porticos six hundred feet long enclosing a shady court.

The social conditions of Hellenic Syria and Egypt, which assured wealth to the ruling class, recurred among the colonial Greeks of Sicily and there too resulted in a display of gardens. Gelon, tyrant of Syracuse (476 B. C.), had a royal park of great beauty. It was well irrigated and contained a wonderful "Horn of Amaltheia," a plot of blossoming fruit trees and flower beds, accounted a masterpiece of the gardener's art. Hiero II of Syracuse achieved the fantastic in horticultural art. On the upper deck of a monster pleasure ship he laid out a roof garden, which was provided with walks, pergolas, and arbors covered with ivy and grapevines; shrubs and flowers were planted in casks of earth to complete the effect.

The use of flowers runs through all Greek life. Every dwelling seems to be in touch with some garden. The people have the tender feeling for flowers that characterizes one who has cultivated his own garden. In all their public celebrations and in their common daily life the Greeks made an extraordinary demand for flowers, which expert florists supplied all the year round. There was a regular succession of blooms, from the white violet of mild days in winter and the early plum to the autumn flowers which, when planted in sunny and protected spots, prolonged their season far into the winter.

"Violet-wreathed Athens" had daily flower markets where many varieties of roses and violets were sold, besides phlox, hyacinths, narcissus, iris, lychnis, myrtle, lilies, anemones, crocuses, and numerous sweet-smelling shrubs. Flower girls went from house to house, offering their wares for sale or filling a regular order as if they were delivering milk and eggs. Flowers were cultivated in market gardens in the suburbs. Roses received special attention. The bushes were transplanted frequently and were cut back to prevent deterioration of the bloom; or they were burnt back—a treatment known to some modern European florists.

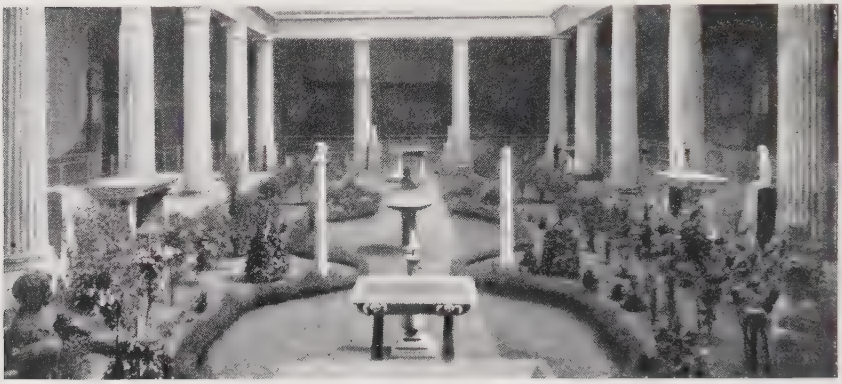

Fig. 9—Restoration of the peristyle garden in the House of the Vettii, Pompeii.

The Greeks constantly varied the native supply of garland flowers by foreign importations and domestication of wild species. They knew which countries produced the finest and most fragrant varieties, but they experienced difficulty in growing these in an alien climate and soil. Domestication presented similar problems. A species of wild thyme was transplanted from the mountains and cultivated at Athens and Sicyon; but as wood plants were often sterile under domestication, considerable art was required to propagate them. A remarkable hundred-leaved rose was grown at Philippi in eastern Macedonia. It had been domesticated from a many-leaved variety which grew wild on the slopes of Mt. Pangaeus near by. As this coast had been the scene of early Phoenician settlement from the neighboring island of Thasos, one surmises that this rose of the Macedonian hills was perhaps an exile from some far Sidonian garden. Or it may have been derived from the garden attributed to Midas by Herodotus, "in which wild roses grow, each one having sixty petals, and surpassing all others in fragrance."

ROMAN GARDENS

The practical Romans, for centuries a race of farmers, reveal the slow evolution of aesthetic horticulture from the merely economic; eventually they gave it the final touch of beauty and magnificence. In ancient Latium, as in Greece, the garden was part of every farm. Primarily for fruits and vegetables, it included also flowers for the garlands used in ceremonies. An ancient scene reported by Roman tradition is that of Tarquinius Superbus (534 B. C.) in his garden showing a perturbed official how to handle a threatened revolt, by silently striking off the heads of the tallest poppies as he sauntered down a path. Cato the Elder (d. 149 B. C.) states that every farm garden should contain flower beds and ornamental trees, like the nuptial myrtle, the Delphic and Cyprian laurel, and that it should be laid out near the house.

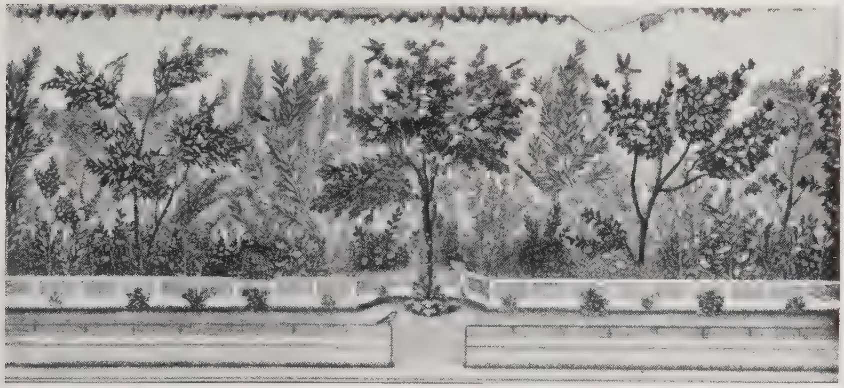
FIG. 10—Restoration of a garden fresco in the House of Livia before the Porta Prima of Rome. (Antike Denkmäler, Vol. 1, Berlin, 1891, Pl. 24.)

Two centuries later Columella, in his "Carmen Hortorum," describes the garden of a large estate, emphasizing the flowers, which he calls "those earthly stars . . . the violet beds unfold their winking eyes . . . the rose abashed with modest blush unveils her virgin cheek," "the horned poppies with their wholesome fruit and poppies which fast bind eluding sleep," "plants of a thousand colors." This is a farm garden. Its flowers, along with vegetables and fruits, are packed into white osier baskets and sold in the nearest market town. The flower trade pays, for "the vendor, with staggering pace and soaked with wine, joyfully from town returns, weighed down with cash."

The demand for flowers increased with increasing luxury in the late republic and the empire. In early times public benefactors were honored by simple chaplets of leaves; later, crowns of blossoms became customary. From Rome's early days garlands decorated the temples of the gods, the domestic Lares, and the sepulchers; but later in private life their use increased. At banquets roses were scattered on the tables and crowned the guests. "Let not roses fail the feast, nor lasting parsley, nor the lily soon to die."

Horace states that in his time flower gardens had become a great national indulgence, displacing field crops. The territorial expansion of imperial Rome caused an economic reaction upon production in Italy, a reaction that was strong and immediate, owing to easy maritime communication between Rome and remote parts of her empire. The importation of provincial grain into Italy discouraged agriculture and interrupted the normal evolution of tillage. But a partial readjustment followed when Roman farmers concentrated on intensive garden and fruit culture and thus specialized in products that were proof against foreign competition. The change stimulated the finer aspects of horticulture, while increasing population and wealth multiplied the demand for the rarer products, whether flower, fruit, or vegetable. Thus an improved floriculture constantly enlarged the element of beauty in the Roman kitchen garden.

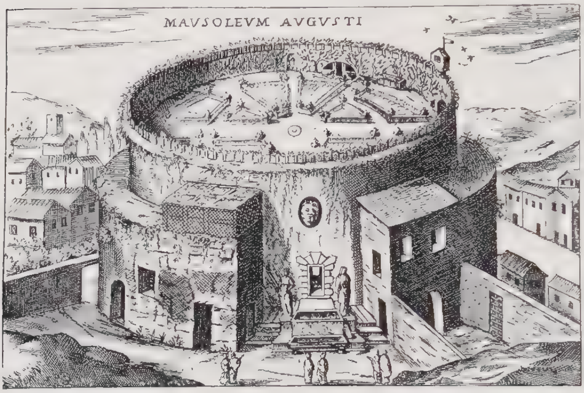

Fig. 11—The Mausoleum of Augustus turned into a garden. (After Lanciani: The Ruins and Excavations of Ancient Rome, 1897, Fig. 182, p. 463; courtesy of Houghton Mifflin Company.)

Furthermore, increasing contact with Greeks and Asiatics, who already had a highly developed horticulture, and the growing wealth of the patrician and equestrian orders at Rome combined to make the pleasure garden the fashion in Italy. Riches and slaves poured into the country from the eastern provinces. A force of expert workmen was at hand just when a cultured capitalistic class at Rome was looking for new and refined enjoyments and when the wear and tear of city life and the excitement of political campaigns drove the wealthy to provide rural retreats for themselves. They began to convert old farms into country estates with shady groves, formal garden, and summer dining room in marble pavilion. Or they built smaller suburban villas, each with its pleasure garden, like that of Diomedes near Pompeii and of the Younger Pliny at Laurentum. The millionaires laid out their gardens in the city and there, within enclosing walls, made their green retreats. The building of villas became a passion among the Romans. Cicero, in addition to his ancestral estate at Arpinum, bought seventeen others which he improved and occupied from time to time. Lucretius, writing in 61 B. C., pictures the restless high-class society of his day vibrating between town and country house.

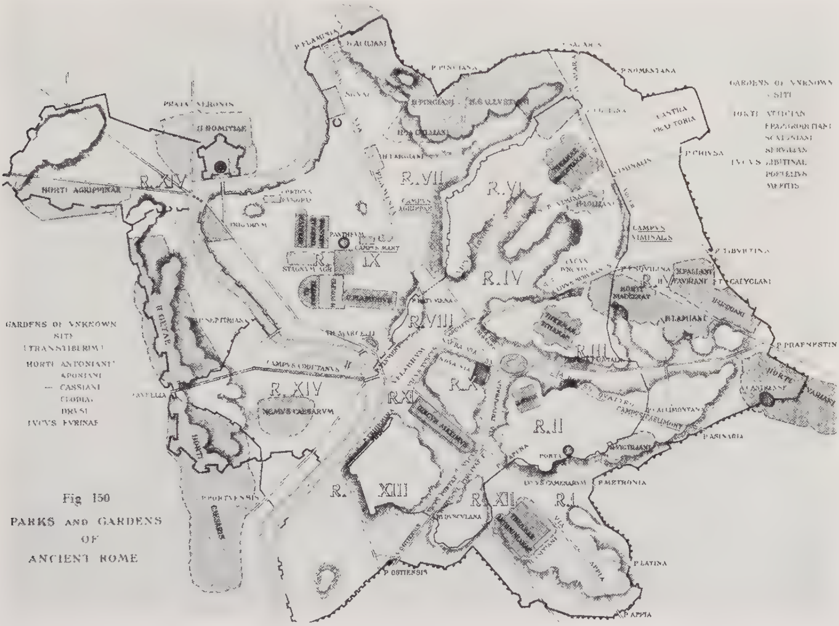

FIG. 12—The parks and gardens of ancient Rome. (Reproduced from Lanciani: The Ruins and Excavations of Ancient Rome, 1897, Fig. 150, p. 394; courtesy of Houghton Mifflin Company.)

Private pleasure gardens therefore abounded within and without the capital. A map of imperial Rome shows them extending over the hills for two miles or more on both sides of the Tiber, almost encircling the city with a wreath of green. The significant fact of their distribution is their paucity within the old city of the Seven Hills enclosed by the Servian walls and their great number and expanse immediately outside them. The inner city, even in imperial times, contained only the garden of Lollia and part of the garden of Maecenas.

The outer girdle of green comprised the Pincian Hill, the ancient *collis hortorum*, where lay the gardens of the Acilian family and Pompey, the sumptuous gardens of Lucullus which later became the haunt of Messalina, and the beautiful grounds of the historian Sallust, which in the Italian Renaissance became the site of the famous Villa Ludovisi. The green belt curved east and south through a long series of gardens, most famous of which were the *Horti Maecenatis*. These were laid out above an old potter's field and dumping ground of the Esquiline Hill, which Maecenas covered with twenty feet of earth and converted from a plague spot into a place of beauty. The low plain west of the Tiber and the slopes of the Janiculum and Vatican Hills were covered with imperial gardens. Lanciani estimates that the capital under the Caesars had one-eighth of its area laid out in gardens and therefore was provided with lungs as are few modern cities.

We have scant data as to the size of the gardens. Those of the emperors and nobles were undoubtedly large, like that of Maecenas, which measured about 1000 by 300 feet, some seven acres. However, this area included the palace and various other buildings which constituted a rich establishment; so that the planted spaces were probably small. The ruins of the imperial palace on the Palatine Hill contain traces of a formal garden two acres in extent, measuring 525 by 156 feet. These gardens were large, considering their location within the city; but one represented wealth, and the other imperial power.

The famous porticoes and gardens of the Campus Martius presented a total length of over three miles of covered walk and sheltered an area of about six acres; but they enclosed garden spaces amounting to sixteen acres. The *Porticus Liviae*, which Augustus laid out as a public garden on the Esquiline Hill, has left remains sufficient to indicate its size and character. It was a sunken parterre two acres in extent (377 by 246 feet), approached by a flight of steps from above and surrounded by a double colonnade which overlooked the central garden space. This isolated *Porticus* was probably typical of those in the Campus Martius and suggests a taste for small and finished garden plots even as public parks.

Outside the city the gardens were large wherever wealth abounded. Magnificent villas with beautiful grounds were distributed along the main highroads within easy chariot ride of the capital. They occupied all the choice sites in the Alban Mountains, an old volcanic region of fertile soil, deep woods, lakes and springs, fifteen miles southeast of Rome. High up on the northern slope, above modern Frascati, Cicero had his Tusculum villa with gardens laid out in terraces and shady groves, one of which he called the Academy and another the Lyceum. Near by Lucullus had one of his sumptuous estates, with formal walks, open pavilions, and outlook towers.

The Sabine Mountains on the western flank of the Apennines had many villas about Tibur (Tivoli), notably those of Maecenas, Augustus, and Hadrian. The seashore also had its country estates, not only Ostia and Laurentum, which were within easy reach of Rome, but also remoter points like Antium and the beautiful region about the Bay of Naples. When the Italian Renaissance revived the ancient type of gardens, many estates like the Villa d'Este at Tivoli, the Villa Aldobrandini at Frascati, and the Villa Barberini at Rome occupied the sites of the once famous gardens of Hadrian, Lucullus, and Nero.

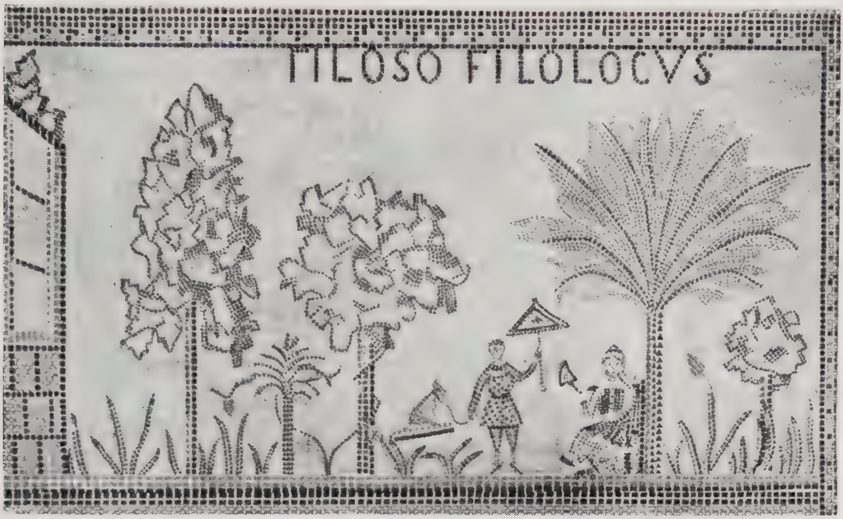

FIG. 13—Woman in a garden: mosaic in the Baths of Pompeianus. (After Charles Tissot: Géographie comparée de la Province Romaine d'Afrique, Paris, 1884, Vol. 1, Pl. 3.)

Moreover, they utilized ancient statues and vases which came to light when the soil was dug up for the new plantations.

The detailed description left by the Younger Pliny of his suburban villa at Laurentum and his country estate in Tuscany reveal the leading features of ancient Roman pleasure gardens. Like the Egyptian and Greek gardens, these were formal in design and were connected with the dwelling, so that life indoors and out was not divorced. The typical villa had a long portico opening upon a terrace. This was the *xystus* of the garden and served as an open-air drawing-room. Its level surface was covered with turf, broken here and there by beds of violets, crocuses, lilies, or other low flowers, each kind by itself in a separate plot. Its outer edge was bordered by box or other shrubs, trimmed often in fantastic shapes as in Pliny's Tuscan garden, or by a low marble balustrade recessed at intervals to hold a tall marble vase or fountain basin, as depicted in the wall paintings in the Palace of Livia at Prima Porta and the garden frescoes of Pompeii.

The *xystus* overlooked a lower garden, or *ambulatio*, with which it was connected by broad steps or a grassy ramp. Seen from above, the *ambulatio* presented the appearance of a varied mass of foliage grateful to the eye. But the shining green of the pomegranate trees was pricked by the nasturtium red of its fruit. The pure yellow of the citron and the pale buff of the quince stood out against the dense green behind; for these fruits served the same decorative purpose as the lemon and orange later in the Renaissance gardens of Italy and the Moorish gardens of Spain. They contrasted with the solid masses of the flowering laurel and the pink or white oleander bushes, and their rounded tops of green with the slender spires of the cypresses.

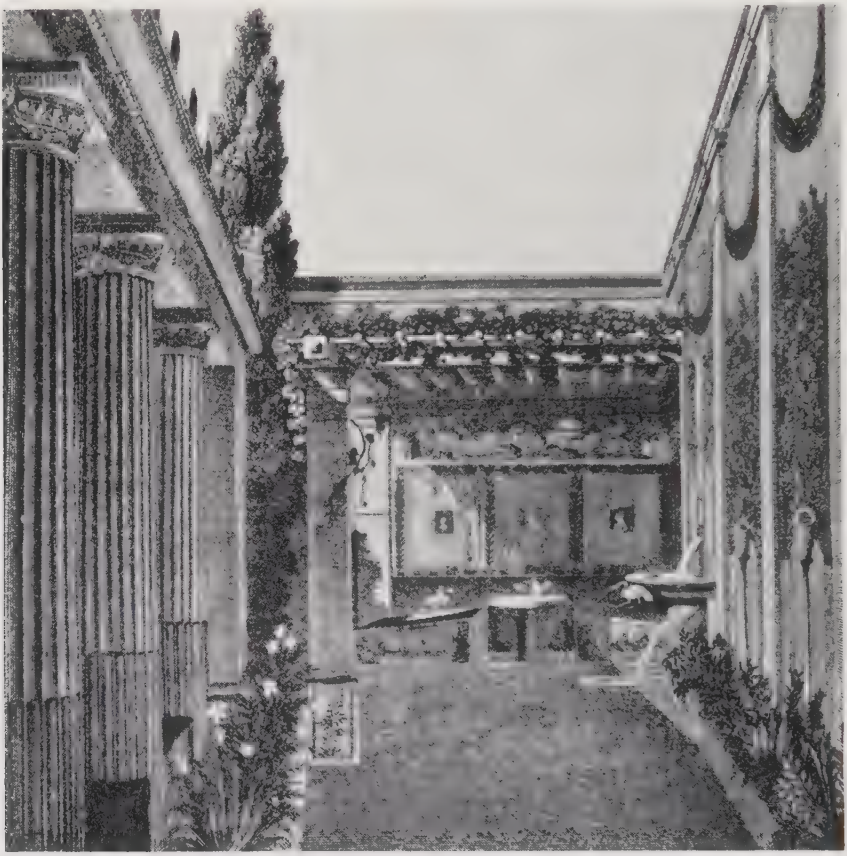

Fig. 14—Garden of the House of Sallust, Pompeii. (After François Mazois: Les ruines de Pompéi, Paris, 1824, Pt. 2, Pl. 38.)

This *ambulatio*, or second part of the typical Roman garden, was planned for leisurely strolls after a meal when mild exercise was joined to conversation. It consisted, therefore, of shaded walks and alleys for use when the sun was hot and of open paths for twilight hours. The spaces between the walks were planted with fruit or shade trees; but where a vista opened to sea or mountains the eye ranged across low beds of hyacinths, asters, jasmine, and roses.

The third section of the Roman garden was the *gestatio*, the shaded avenue where the master took his airing on horseback or in a litter carried by slaves. It either encircled the *ambulatio* or was laid out quite apart, usually in oval form. In either case it was bordered by a fancifully cut box hedge or by dwarf plane trees; for the Romans had discovered the art of dwarfing trees by peculiar methods of planting and topping them. The topiary art of clipping trees and shrubs was introduced into Rome from Syria about the beginning of the Christian era.

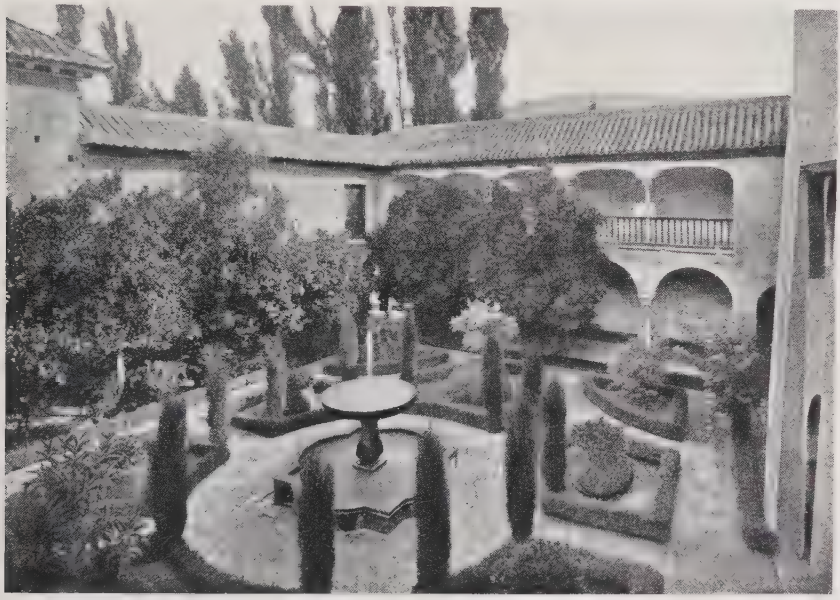

FIG. 15—Patio of the Linderaja, the Alhambra.

Gardens were not the monopoly of the rich and noble in ancient Italy. The remains of Pompeii show them attached to the average town residence scaled down to the size of a town lot. The old Italic *atrium* house of Pompeii had a small garden in the rear, enclosed by extended side walls of the dwelling and a cross wall at the back. It was therefore as wide as the house but usually quite shallow. The House of Sallust, built in this old style in the second century before Christ, had such a garden, 60 feet long and only 20 feet wide. Though small, it had all the elements of the traditional garden.

Pompeii lay in a region of ancient Greek colonies and had a considerable Greek element in its population, as indicated by numerous family names. Hence the Greco-Roman peristyle type was established here in the second century before Christ and prevailed in the handsomer dwellings. The peristyle court was adorned with flower beds vases of growing plants, fountains, water basins, and statues. All were arranged with studied symmetry, as the traveler sees them today in the great peristyle (33 by 65 feet) of the House of the Vettii, which has been restored and replanted according to the original plan.

Behind the peristyle and its apartments usually lay the garden or *viridarium*. The portico façade thrust out wings at either end and enclosed the garden on three sides by colonnades. A Pompeian wall painting depicts this type of semi-inclosed garden, evidently borrowed from Greece as it resembles the Cyzicene house garden described by Vitruvius.

As population increased in Rome and the private houses of the old city were superseded by tall apartment houses (*insulae*), the little gardens were crowded out; but in their stead window boxes of growing plants were introduced "to pasture the eyes on," Pliny says. Roof gardens crowned the city buildings with shrubs, grape arbors, fruit and shade trees, all planted in boxes of earth, while high above the street marble-rimmed fish pools reflected the blue sky or the silent stars.

The Roman type of garden may have been transplanted to Carthage on the conquest of Africa in 146 B. C.; or the conquerors may have occupied unaltered the fine villas that surrounded the Punic capital with their gardens and orchards from early times. In 310 B. C., when Agathocles of Sicily marched on Carthage, he passed through a cultivated and irrigated region, Diodorus tells us, occupied by the landed estates of the Carthaginian nobles, "which they improved for their delight and pleasure." Centuries later villa parks of surpassing beauty still persisted. Aesthetic gardening was a natural development for a people who inherited the principles of Phoenician horticulture, who produced an authority on tillage like Mago, and who, like the Romans, had a rich and privileged class.

Gardens in Spain

Ancient Spain has left no record of pleasure gardens, though, under the favorable conditions of climate and relief, they may have readily developed from the intensive tillage of the native Tartessians and the colonial Phoenicians, Greeks, and Romans who settled on those shores. Strabo (b. 63 B. C.), sailing up the Guadalquivir, described with enthusiasm the beauty of the "orchards and gardens which in this region are met with in highest perfection"; but he failed to specify pleasure gardens. Here at Gades (Cadiz) was born Columella of Roman blood, who more than any other writer on ancient horticulture sang the praises of flowers, as he had seen them grow in his father's gardens beside the Guadalquivir.

With the Saracen conquest in 711 A. D. Spain begins to glow with the beauty of its gardens. The Arab conquerors, conservators of ancient Mediterranean civilization in an age of barbarian invasions, had already mastered the art of gardening in their eastern homes; they embodied the ideal of their craft in the Moslem dream of paradise. But the environment of Spain produced the perfect efflorescence of this art, because it gave to the craftsman incentive, opportunity, abundant material, and abundant reward. The gardens of Spain became a revelation of the Saracen spirit finer even than the dream of paradise. Here race and environment seem to have combined to produce perfection; but it must not be forgotten that the previous habitat of this conquering race lay among the orchards of apricot and almond, among vineyards and balsam groves, and beside pools and rivulets of Yemen and Mecca. Who tilled those narrow terraces, who watered those slender garden plots earned beauty as well as life.

Many of the old gardens of Granada have survived Christian depredations. The fact that impresses one here is the succession of small gardens incorporated in the architectural mass of the Alhambra and the Generalife—the group of jewel spaces, each in a setting of stone walls or stucco arcade, each exquisite and distinct in itself. Such is the little Patio of Lindaraja with its alabaster fountain, its thicket of roses and myrtle and citron and orange, tempering the noonday glare to a mysterious gloom. Such is the *Jardin los Adarves* with its vine-covered trellises and its blossoming trees looking toward the snowy Sierra Nevada. The Generalife too reveals the charm of small and perfect gardens. Here they glow with sunlit flowers; there they are subdued to deep shade in a sunken water garden, whose green pool is overhung by lines of aged cypresses. This composite grouping recalls the complex garden enclosures of Egyptian Thebes, of Rome, Tibur, Tusculum, and the Naples country; and it makes one realize that the Egyptian Pharaohs, the Roman Caesars, and the Moorish Sultans all planned their gardens after one common model.

The arcade about the Generalife "Garden of the Pond" bears the inscription: "Charming place! thy garden is adorned with flowers which rest on their stalks and exhale sweetest perfumes; fresh breezes stir the orange tree and spread abroad the fragrance of its blossoms. I hear voluptuous music mingled with the rustling of leaves in thy grove. Everything about is harmonious, green, flowering."

"Awake, O north wind; and come, thou south; blow upon my garden that the spices thereof may flow out." East meets West, the garden of Palestine and the garden of Granada.

FLOOD-WATER FARMING

Kirk Bryan

Harvard University

THE usually clear distinction between irrigated and unirrigated farm land breaks down in the consideration of marginal lands irrigated by flood water. In some instances there is a complete transition, and fairly well designed irrigation systems are maintained to utilize water during the time of heavy run-off in the spring, although enough water may be available for only one irrigation. There are also areas of meadowland that were originally more or less flooded and are now maintained as "wild hay" land by simple diversions and by drainage. But in the western United States there are also many areas, usually of small acreage, where the growth of a crop is dependent on sporadic and muddy floods. No regular system of diversion or of conveyance of water is maintained; but areas selected as likely to be flooded are planted, and those portions of the field not too badly washed by water or covered by silt make the crop. This is flood-water farming, a precarious type of agriculture, long practiced in our Southwest in both ancient and modern times. It should be distinguished from dry farming, in which after each rain the soil moisture is conserved by producing a dust mulch that prevents evaporation.

The two types are alike in that the fields are generally isolated and frequently abandoned. Both types are dependent on the uncertainties of the weather, and hence such fields are called by Spanish-speaking people, *temporales*. The irrigated field is a *labor* or *labor regado*. *Sembrado*, "a planting," is also used as a substitute for *temporal*, as all such fields are more often planted than harvested. As maize, or Indian corn, is the principal crop, the Nahuatl word *milpa* is also used, although more strictly it means a cornfield whether irrigated or not.

Flood-water farming is practiced in the more remote areas of the Southwest and was more prevalent in the early days of settlement than at present. Some recent studies by Quesenberry[1] indicate that it may still play a part in the modern development of the region. The purpose of this paper[2] is to consider the geographical relationships of the practice of flood-water farming and to consider the decline in acreage in relation to recent changes in stream channels. This complex relationship has also an anthropological importance since flood-water farming was one of the important sources of livelihood of the prehistoric sedentary Indians of the Southwest.

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[1] F. R. Quesenberry, in an unpublished bulletin of the New Mexico Agricultural College.

[2] Collection of data on flood-water farming has continued over a number of years and was much facilitated during the past season by a grant from the Shaler Memorial Fund of Harvard University. Thanks are also due to J. L. Burkholder, chief engineer of the Middle Rio Grande Conservancy District, Albuquerque, N. Mex., for permission to use material gathered for the district and to Gen. H. F. Robinson, supervising engineer of the U. S. Irrigation Service, Albuquerque, for the use of maps prepared under his direction for other purposes.

Modern Flood-Water Farming

Save in exceptional places and at altitudes above 6500 to 7000 feet the rainfall of New Mexico and Arizona is ordinarily too scanty to mature crops. At higher altitudes the growing season is short, and in many open valleys among the mountains corn cannot always be matured. Here also the fields are small and the area limited. In the vast, open alluvial basins and on the extensive plateaus of the region large areas of good soil are available. Here, where living waters suitable for systematic irrigation do not exist, flood-water farming has its place.

The areas utilized are variable in size and location, but each is chosen so that the local rainfall may be reinforced by the overflow of water derived from higher ground. The selection of a field involves an intimate knowledge of local conditions. The field must be flooded, but the sheet of water must not attain such velocity as to wash out the crop nor carry such a load of detritus as to bury the growing plants. Such conditions require a nice balance of forces that occur only under special conditions. Shrewd observation and good judgment are necessary in the selection of fields.

The sites chosen fall obviously into two main types: gentle slopes below rock or shale escarpments, valley floors inundated by sheet floods. At sites of the first type the watershed is limited in area and consequently in run-off, but the run-off is large in proportion to the rain. Thus even "little" rains produce a good run-off. The locations of the second type fall into two classes: those where the water of a stream channel spreads out over an alluvial fan at the so-called "arroyo mouth" and those adjacent to large streams which overflow their flood plains. It is obvious, however, that these types more or less grade into each other, and their separation is largely for convenience in description.

Fields below Escarpments

The Spanish-speaking inhabitants of little valleys in the Sandia Mountains, New Mexico, cultivate cornfields at or near their scattered ranches. Settlements were made at these localities about 1815 and reached a more or less stabilized condition in 1850 or shortly after the American conquest. Farming is not the sole resource of these people

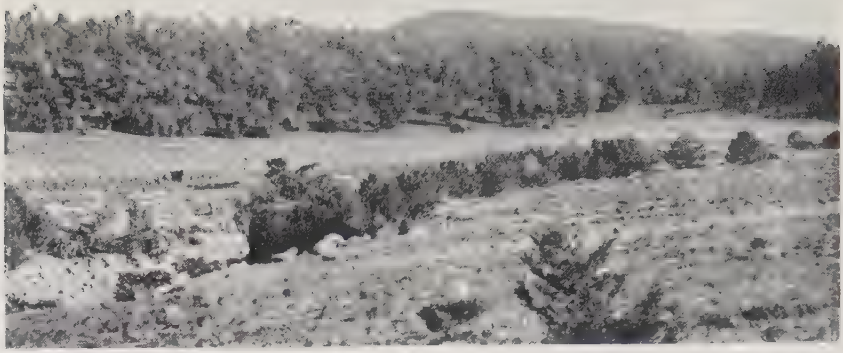

FIG. 1

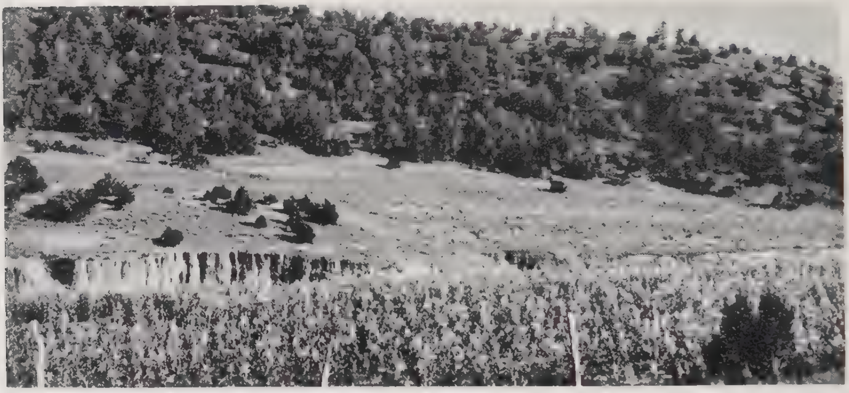

FIG. 2

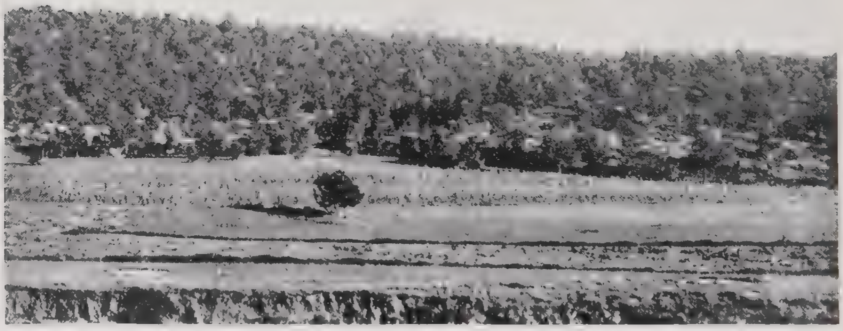

FIG. 3

FIGS. 1, 2, 3—Cornfields in Gutierrez Canyon, Sandia Mountains, Bernalillo County, N. Mex.

The recently deepened arroyo in the middle ground of Figure 1 no longer overflows the field which is irrigated by the unregulated run-off of the encircling slope.

The fields of Figure 2 below the rocky wooded slope are irrigated only by the unregulated run-off of the slopes; the field in the foreground is irrigated by diversion of flood water.

The cornfield of Figure 3 lies on an alluvial fan on which the flood run-off from a shallow valley in the rocky slope is spread.

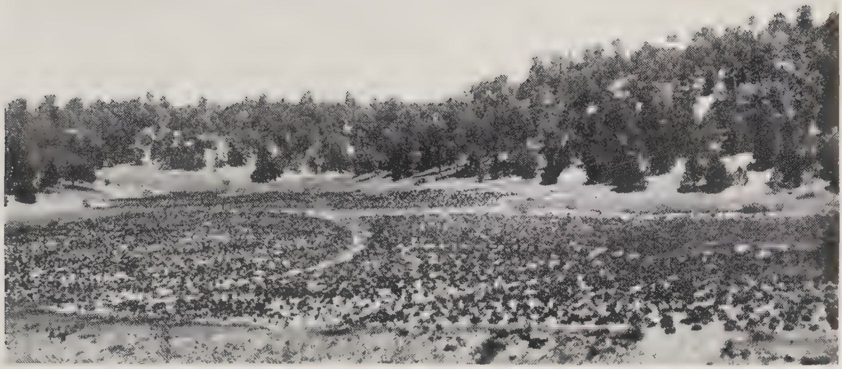

FIG. 4

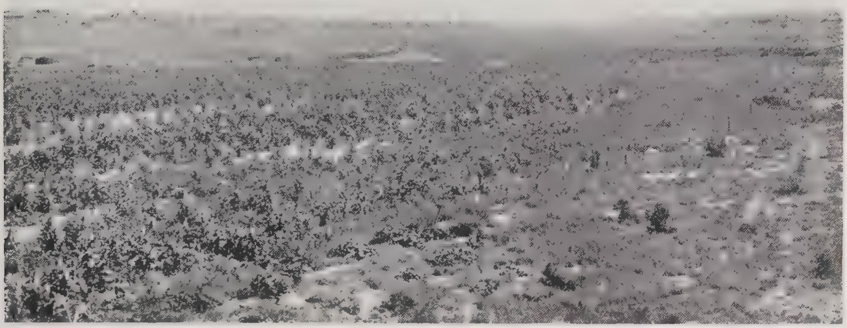

FIG. 5

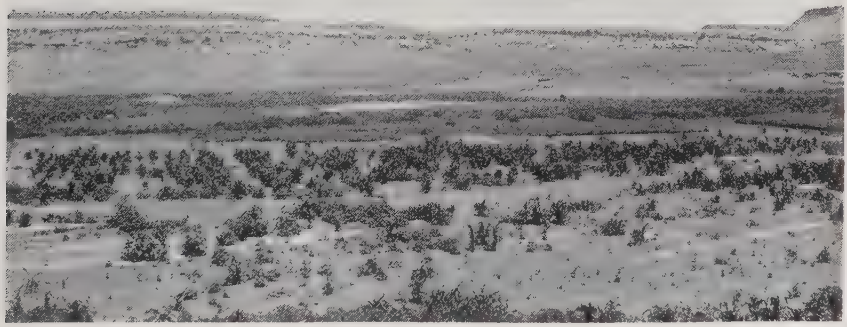

FIG. 6

FIG. 4—Bean field near Sedillo, Bernalillo County, N. Mex. Irrigated by run-off from the rocky slopes of the background.

FIG. 5—Fields in Arroyo en Medio, view almost due north; note squash plants in the foreground. See Figure 9 for position from which photograph was taken.

FIG. 6—Fields in Arroyo en Medio, view nearly west to sandstone hillock; note destructive wasting in center of view. See Figure 9 for position from which photograph was taken.

as they all own a few head of stock and also cut and haul firewood to Albuquerque twenty miles distant. At various times coal mines and limekilns have flourished. Rough stone for foundations is also gathered and hauled to town. In the past ten years the area has become popular with the inhabitants of Albuquerque for picnics and for the location of summer residences. Land values are rising, and the old order is passing.

A typical field is shown in Figure 1. It lies along the stream of Gutierrez Canyon, a tributary of Tijeras Canyon (Cañon de Carnuel) at an altitude of about 6500 feet. In the background, largely concealed by the scrub cedar (juniper) and piñon trees, is an encircling slope of almost bare sandstone ledges. In a rain, water pours off this slope in a thin sheet. Part is derived directly from the rocky slope, and part is spread on the incipient alluvial cones visible in the view. In the first week in September, when the photograph was taken, the corn was mature and the yield moderately good. In the right foreground is a field not cultivated in 1928. The Gutierrez Arroyo at this place is now about 20 feet deep, whereas according to local inhabitants it was once shallow and inconspicuous. The floods are now confined within the deep channel, whereas once they spread over the borders of the fields and gave to these parts an additional supply of water.

The fields shown in Figure 2 lie about three miles downstream from the area just described. In the middle background, on the far side of Gutierrez Arroyo, the corn plants are small and there are few ears. In 1928 less rain fell at this place than three miles upstream. The field in the foreground has, however, an excellent crop; but it was irrigated by flood water diverted from the arroyo by a crude dam. On several critical occasions water came down the arroyo when there was no local rainfall. The contrast in productiveness of the two fields is marked. In the early days, when Gutierrez Arroyo was less deep, simple diversions of such a character were easy and much more numerous.

Beans are also planted under somewhat similar conditions, and such a field is illustrated in Figure 4. This is near the town of Sedillo and at a little higher elevation than the fields previously described. More dependence is placed on the somewhat greater average rainfall. Nevertheless, this field is flooded by the run-off of the surrounding hills, which is only partly concentrated in the curving channel that runs through it.

A transition type is shown in Figure 3. This field is also in Gutierrez Canyon and is located on the alluvial fan of a tributary. The beans planted in the plowed strip, in the middle ground between the isolated tree and the arroyo, failed to receive much water and by September were shriveled and dry.

Fields at the "Arroyo Mouth"

In the Papago country of southern Arizona the flood run-off of the mountain areas is gathered in streams with well defined channels which on reaching the great undissected alluvial basins spread out into sheets. The place where this spreading occurs is called by the Papago Indians *Ak-Chin*, "arroyo mouth." These are favorite situations for flood-water fields, and more than six villages or localities once inhabited in Arizona and Sonora are called Ak-Chin or a corrupted form of the same name.

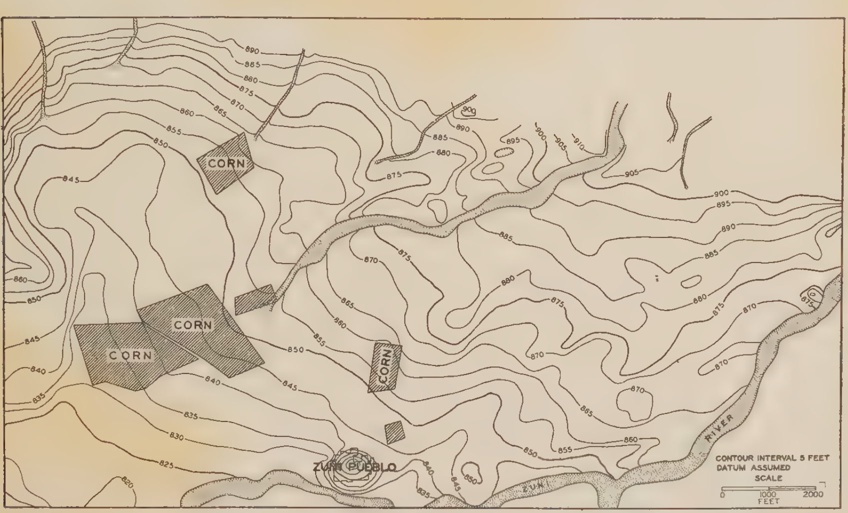

FIG. 7—Map of part of Zuñi Valley, McKinley County, N. Mex., showing areas fenced for cultivation of corn in 1908 before irrigation of the valley by water stored in Zuñi Reservoir. (Redrawn from map by U. S. Indian Irrigation Service).

Localities where flood waters derived from a channel or arroyo spread out in a sheet are fairly common, but they have been much reduced in number by the recent trenching of the channels of streams. In Zuñi Valley, McKinley County, New Mexico, such localities have always been used for fields by the Zuñi Indians. In 1906 the U. S. Indian Irrigation Service began the construction of an irrigation system for these Indians, and a topographic map of the land to be irrigated was made in 1908 (scale 1 inch to 500 feet; two-foot contour interval). Part of this map, with a much reduced scale and a five-foot contour interval, is reproduced in Figure 7. The Zuñi River runs in a well defined arroyo which at that time had banks 15 to 20 feet high. Since the completion in 1908 of the Zuñi Dam, nine miles east of Zuñi Pueblo, only small quantities of water have been carried by the river. The sand contributed by two large arroyos that enter the river below the dam has filled the channel at least four feet at Zuñi Pueblo. The deep channel of Zuñi River is relatively recent and, as indicated by a study of early surveys, was cut between 1880 and 1902, or in the general period when channel trenching took place in the Southwest.

The lateral tributaries of Zuñi River, except the two previously mentioned, are not entrenched. They arise in the intricately carved borders of the neighboring mesas. These mesas of red shale and red and white sandstone rise to elevations of 7000 feet, whereas the floor of the valley lies between 6100 and 6200 feet. The flood waters pour down through well defined channels, or arroyos, with banks five to ten feet high and sandy or gravelly beds. On reaching the valley floor the floods overflow the channel and, depositing the coarser material near the bank, produce natural levees. The channel becomes shallow and finally disappears. The place where the channel disappears is the place most frequently overflowed, the "arroyo mouth." The distribution of fields in 1908 with respect to these arroyos was notable. The area shown as field is about 165 acres; but these are the fenced areas, and, according to the usual practice, only parts of these areas were actually planted and still smaller parts were harvested. At various places in the valley floor low mounds are shown by the contours, and there are also undrained depressions. These mounds are piles of wind-blown sand which are effective in the spreading of flood waters.

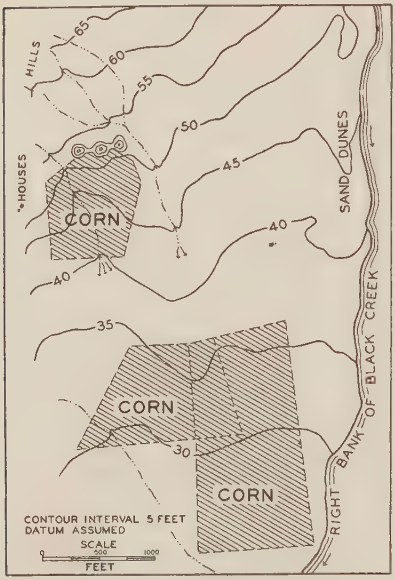

FIG. 8—Map of part of Red Lake Irrigation Project, Navajo Reservation, N. Mex., showing areas fenced for cultivation of corn in 1925 before irrigation by water stored in Red Lake Reservoir. (Redrawn from map by U. S. Indian Irrigation Service).

Another illustration, on the Red Lake Irrigation Project within the Navajo Reservation in northwestern New Mexico, is given in Figure 8.

Fields in Main Valleys

Examples of flood-water fields in main valleys are now rare. The deepening and widening of stream channels in late years has been so complete that few undissected valleys remain.[3]

Such an undissected valley is that of Arroyo en Medio, a tributary of the Rio Puerco by way of the Arroyo Torreones (Torrejon) and the Arroyo Chico. The valley is 11.5 miles long, and the drainage area is about 30 square miles. A deep channel, or arroyo, has cut back from Arroyo Torreones a distance of a mile and a half. At its junction with Arroyo Torreones this arroyo is 22 feet deep and 28 feet wide. The head is a chaos of gullies and blocks of clay, a sign of active headward erosion. Downstream from this point all the flood water is confined in the channel, and the valley floor is no longer overflowed.

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[3] Kirk Bryan: Date of Channel Trenching (Arroyo Cutting) in the Arid Southwest, *Science*, Vol. 62 (N. S.), 1925, pp. 338–344; *idem:* Historic Evidence on Changes in the Channel of Rio Puerco, etc., *Journ. of Geol.*, Vol. 36, 1928, pp. 265–282.

About a quarter of a mile above the head of the arroyo the valley floor is occupied by fields, embracing 55 acres, cultivated by Navajo Indians. The valley floor above the fields is narrow and marked by a deep channel which holds any ordinary flood. In one place it is 15 feet deep, but for the most part it is from 5 to 12 feet deep. Near the sandstone ledge that almost blocks the valley the channel disappears and the flood waters spread out. This process was originally entirely natural, but at present it is more or less aided and controlled by the Indians. The spreading waters deposit part of their load of silt, so that the field is softer and also sandier than most parts of the valley floor. In places the currents are so swift as to destroy the corn, but in general the crop is good. The new deep channel, or arroyo, as it works headward, menaces the fields, which before many years must, like so many others, be abandoned.

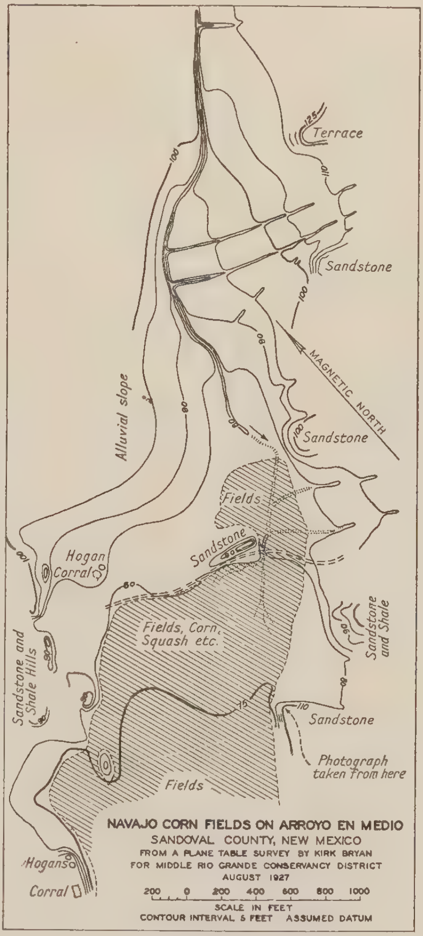
Terrace
Sandstone
MAGNETIC NORTH
Sandstone
Alluvial slope
Fields
Sandstone
Hogan
Corral
Fields, Corn, Squash etc.
Sandstone and Shale
Sandstone and Shale Hills
Sandstone
Photograph taken from here
Fields
Hogans
Corral
NAVAJO CORN FIELDS ON ARROYO EN MEDIO
SANDOVAL COUNTY, NEW MEXICO
FROM A PLANE TABLE SURVEY BY KIRK BRYAN
FOR MIDDLE RIO GRANDE CONSERVANCY DISTRICT
AUGUST 1927
200 0 200 400 600 800 1000
SCALE IN FEET
CONTOUR INTERVAL 5 FEET ASSUMED DATUM

FIG. 9—Map of fields cultivated by Navajo Indians in Arroyo en Medio, Sandoval County, N. Mex. Compare Figures 5 and 6.

In 1928 a smaller group of fields similar in location was being cultivated in Cañada de la Piedra Lumbre, a companion tributary of Arroyo Chico. Similar places in various parts of the plateaus in northwestern New Mexico and northern Arizona are cultivated nearly every year, especially on the Navajo Reservation, where, according to Gregory, 20,000 acres were farmed with flood water in the period from 1909 to 1915.[4]

Contrast between Indian and Spanish Farming

The kinds of places suitable for farming under the system have been outlined. These sites have existed from the time of prehistoric settlement; but cultivation, by its disturbance of the surface, leads to washing and channeling, which temporarily or permanently ruin a field. Thus at the same site the best places to plant are limited in area and changeable in position. The Indians of the present day, like their prehistoric ancestors, hardly disturb the ground, as they do not plow but merely insert the seed in a hole made with a planting stick. They select each spot that is to be seeded and by deep planting assure a strong root system capable of resistance to drought and to some surface washing by flood water. Even with the use of their methods fields must be periodically abandoned for later reoccupation. One of the principal causes of such shifts in location lies in the habits of ephemeral streams in the stage of alluviation. Such a stream has a discontinuous channel. For several hundred yards or for a mile or more it runs in flood as a thin sheet. As there is no low water or permanent flow, there will be left, on the recession of the flood, a smooth valley floor with almost no trace of a channel. Downstream from such a flat a channel begins suddenly and may be from 2 to 20 feet deep, according to the size of the ordinary flood that is to be carried. This channel may continue for yards or miles and then rather suddenly fade out in another channel-less flat. The flats are the best sites for cultivation, and the characteristics of such areas are well shown in Figure 9. These phenomena are obviously due to adjustments between load and discharge of the stream for the maintenance of as smooth a grade as possible. Obviously also, with variable discharges of water and silt by tributary streams, the proportionate load of the main stream varies, and the location of the discontinuous channels and broad flats varies in position through the years. The best situations for fields also vary with these changes.

To the Indian such shifts were usually of little importance as he farmed only for subsistence and was accustomed to walk long distances from his village to his fields. The Papagos[5] and Hopis even today cultivate such fields 20 to 30 miles from their winter residences. These long distances are frequently traveled afoot, and before the Spanish conquest the crop was carried home on the backs of men and women.

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[4] H. E. Gregory: The Navajo Country, *U. S. Geol. Survey Water-Supply Paper 380*, Washington, 1916, pp. 103–105.

[5] J. W. Hoover: The Indian Country of Southern Arizona, *Geogr. Rev.*, Vol. 19, 1929, pp. 38–60; reference on pp. 49–55.

The Spanish conquest introduced two new factors into the practice of flood-water farming. The most important was live stock. Cattle and particularly horses spread far beyond the Spanish settlements and immediately brought about the need of fences. The presence of domesticated animals increased the use of corn, which had been used only for men and turkeys, and the availability of pack animals caused trade to flourish and the value of corn to rise. Thus larger acreages were required, and at the same time the labor of growing crops increased by reason of the fences. The labor is somewhat mitigated by the use of horses and plows in cultivation and of horses and wagons for transportation of the crop. These changes placed agriculture on a more modern and commercial basis—a change which the Indians have resisted so far as possible. Thus one can still find in the more remote districts unfenced fields planted without being plowed.

The Spanish attempted so far as possible to use the same fields continuously and, having iron tools and draft animals, built dams and ditches. So far as possible they attempted to control the floods, and wherever they failed to do so they were heavy losers.

With the American conquest in 1846 the marauding Navajo, Comanche, and Apache were gradually subdued. Settlement spread from the areas of the Spanish and Mexican grants into the public domain. Here the operation of the homestead laws hampered flood-water farming. Only one piece of land could be legally acquired, whereas the settler needed permanent water and one or more fields, *temporales*, which usually could not be found together in one tract of 160 acres. Hence a further inducement was offered for retention in permanent cultivation of flood-water fields. The use of plows and the presence of live stock made surface washing even more common. Consequently many fields were abandoned long before or quite independently of the deepening and widening of stream channels which began about 1880.

Effect of the Recent Epicycle of Erosion

It appears that before 1880 farming by flood water was more extensive then at present. In the main stream valleys, such as the Rio Puerco, it was a thriving business. Here the Spanish-speaking New Mexicans settled about 1870 and built simple diversion works and ditches. In general they were more independent of local conditions than were the Indians, as they had iron and steel tools and live stock. Log and brush dams and at least a short length of permanent main ditch were usually constructed. Juan Bandera, who came from Texas and settled near San Ignacio in 1882, told me that low brush dams were thrown across the channel during later phases of a flood, and the water was diverted into ditches or simply warped over the land. At times of great floods the whole valley floor was inundated and so saturated that no further irrigation was necessary that year. Near Cabezon the channel of the river was so shallow that, according to the recollection of Meliton Chaves, one man could divert the water by felling a cottonwood across the channel and using the branches to make a dam.

Such simple diversions are no longer possible. Only two dams are maintained in the hundred-and-fifty-mile Puerco Valley. These structures, at Cuba and San Luis (Dominguez P. O.), are elaborate contrivances of logs and rock which require much effort to maintain. Along this great stream, because of the deepening of the channel, six small towns and numerous ranches have been abandoned.

On the Rio Galisteo, an ephemeral tributary of the Rio Grande from the east, there were at one time several thriving agricultural settlements. All the farm lands are now abandoned, although some of the towns survive as trading points and headquarters for stock raisers.

The town of Colorado, locally called Coloradito, lay three miles south of Lamy, a station on the Atchison, Topeka and Santa Fe Railway. In the U. S. Land Office Survey of 1883 William White states in his notes[6] that the town had "about 10 houses." The Lamy sheet of the U. S. Geological Survey, which was surveyed in 1890, shows 11 houses and some outlying ranches. But this town has now been deserted for more than twenty years. The inhabitants found it increasingly difficult to maintain a dam across the channel of the Galisteo, which continuously increased in width and depth. Their lands were finally purchased for grazing purposes.

At Galisteo, still a thriving town with gardens irrigated by well water pumped by windmills, J. S. Garretson states in his notes of 1850 that there were cornfields. John Shaw repeats this statement in his notes of 1879.[7] Later surveyors fail to mention cultivation of the land. According to local authorities the arroyo began to deepen about 1884, and cultivation by flood water became increasingly difficult and was abandoned by 1900. And so for various other places.

The accelerated erosion that has been going on since about 1880 has restricted flood-water farming to smaller and more scattered areas and terminated it in the main valleys. The shifts in population that have been brought about by this change in agricultural conditions have been inadequately studied. The number of people involved is relatively small, but the areas are large. With further study of local history many additional examples of these movements of population will be put on record.

In the light of the relation between the state of erosion in stream channels and agriculture the present aspect of the region is deceptive. An accelerated rate of erosion leads to misconceptions in attempts to interpret the life of the prehistoric peoples. Small and large ruins occur in places that appear at present to be barren wastes; yet excavation shows that these ruins were occupied by the ancestors of the modern Pueblo Indians who were as well provided with this world's goods as most of their descendants. These ancients practiced agriculture with maize, beans, and squash as their crops. How, then, did they thrive?

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[6] On file in the Public Land Office, Santa Fe, N. Mex.

[7] The notes of Garretson and Shaw are also on file in the Public Land Office, Santa Fe, N. Mex.

Obviously some of the ruins represent unprofitable ventures, for the ancients could not have been infallible in the choice of town sites. Many ruins, however, testify to long occupation; yet they lie far from living streams and where ordinary irrigation is impossible. Nor does it seem likely that in the past there could have been such a moist climate as would provide living waters in any of the near-by valleys. In fact, there is strong negative evidence against this suggestion, since perennial streams leave characteristic deposits which have not as yet been detected in the alluvium of such valleys. If, however, agriculture by the use of flood water is assumed as the prevalent habit of the prehistoric peoples, the sites of many ruins seem more propitiously located. The abandonment of the sites may also be explained.

According to an authoritative summary by Kidder the Pueblo culture began in small scattered settlements of single houses or small groups of houses.[8] Large communal aggregations, the pueblos, were then built; and this stage is the great epoch of the Pueblo culture. The area occupied by these people extended from southwestern Nevada through most of Utah and part of southern Colorado southward over most of eastern Arizona and the western two-thirds of New Mexico.

In the succeeding stages and before the Spanish conquest the number of villages and the area in which they were distributed were reduced. There was a concentration toward the Rio Grande Valley, and at many places the people appear to have practiced irrigation with living water. Yet even at the time of the Spanish conquest the Hopi, Zuñi, Acoma, Tano, and part of the Tigua and Piro peoples must have been largely dependent on farming by flood water.

A cycle of erosion similar to that of the present, accompanied by trenching of stream channels, drainage of moist valley flats, and great restriction in farming by flood water, would have been an adequate cause for the abandonment of many previously occupied regions. It would have been most effective in the peripheral regions occupied by the Pueblos and may easily have been the cause that brought the Great Pueblo period to an end.

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[8] A. V. Kidder: An Introduction to the Study of Southwestern Archeology, New Haven, 1924, pp. 36–46 and 54–55.

That such a cycle of erosion took place in prehistoric time and was succeeded by a period of alluviation that continued down to about 1880 is supported by an increasing body of fact. A buried channel representing such a cycle of erosion and alluviation has been found at Chaco Canyon and at other localities, notably on Rio Galisteo.[9] The channel formed and filled at about the end of the Great Pueblo period. The collection of data on this episode is still going on, but it appears that an adequate physical cause for the decline in Pueblo culture from its peak and the shifts in population at about that time is in sight. Such an explanation rests on the postulate that flood-water farming was the principal support of the prehistoric people.

Dry Farming of Beans as a New Industry

During the World War the prospect of a shortage of food led to an artificial stimulation of the growing of the pinto bean, a large, speckled, brown bean widely distributed through northern Mexico. The Spanish-speaking people of New Mexico, well aware of the risk of loss, increased the production of beans to about six times the normal. The price was lower than that of white beans, and a market outside the state was found. Since that time the market has expanded, and large areas of grassy plains at the higher altitudes have been used for growing beans. Even with the best dry-farming methods the business is hazardous, and in some years there are total failures. Overflows by the run-off of higher ground are extremely valuable in reënforcing the moisture derived from local rainfall. It seems likely that further study of the primitive methods of flood-water farming will lead to modern adaptations that will be applicable to the otherwise promising business of growing pinto beans.

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[9] Kirk Bryan: Recent Deposits of Chaco Canyon, New Mexico, in Relation to the Life of the Prehistoric Peoples of Pueblo Bonito (abstract), *Journ. Washington Acad. of Sci.*, Vol. 16, 1926, pp. 75–76.

THE GULF STREAM AND ITS PROBLEMS

By H. A. Marmer
U. S. Coast and Geodetic Survey

MAURY'S "The Physical Geography of the Sea," which appeared in 1855, is frequently referred to as the first textbook of modern oceanography. In that work the author devotes the first chapter to the Gulf Stream, introducing it thus:

> There is a river in the ocean. In the severest droughts it never fails, and in the mightiest floods it never overflows. Its banks and its bottom are of cold water, while its current is of warm. The Gulf of Mexico is its fountain, and its mouth is in the Arctic Seas. It is the Gulf Stream. There is in the world no other such majestic flow of waters. Its current is more rapid than the Mississippi or the Amazon.[1]

Even in matters scientific, customs change. It is altogether unlikely that an oceanographer nowadays would speak of the Gulf Stream as rhetorically as did Maury. The magnitude of this current, however, is such that even later students make use of superlatives in describing it. The most comprehensive investigation of the Gulf Stream was carried out between the years 1885 and 1889 by Lieutenant (later Rear Admiral) J. E. Pillsbury, U. S. N., while attached to the Coast and Goedetic Survey. And when he came to write up the results of his observations and studies he described it as "the grandest and most mighty . . . terrestrial phenomenon."[2]

Of all the currents that make up the systems of oceanic circulation, the Gulf Stream has received the greatest amount of study and is the best known. Its discovery, or more accurately the first notice on record, came shortly after the discovery of the new world. Early in March of 1513, Ponce de Leon set sail from Porto Rico with three ships on a voyage of exploration. Setting a northwesterly course the expedition discovered Florida, a landing being made on the eastern coast somewhere in the general vicinity of Cape Canaveral. Sailing southerly then they encountered on April 22, as related in a chronicle of the expedition, "a current such that, although they had a great wind, they could not proceed forward, but backward, and it seemed that they were proceeding well; and in the end it was known that it was in such wise the current which was more powerful than the wind."[3] Thus was the Gulf Stream first noted.

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[1] M. F. Maury: The Physical Geography of the Sea, New York, 1855, p. 25.

[2] J. E. Pillsbury: The Gulf Stream: Methods of the Investigation, and Results of the Research, Appendix No. 10 of *Rept. of the Supt. of the Coast and Geodetic Survey for 1890*, Washington, D. C., 1891, pp. 459–620; reference on p. 472.

[3] L. D. Scisco: The Track of Ponce de Leon in 1513, *Bull. Amer. Geogr. Soc.*, Vol. 45, 1913, pp. 721–735; reference on p. 725.

Apparently the Spaniards soon learned that this northerly-flowing current was not merely a local current but one of wide extent; for six years later, when Antonio de Alaminos set out for Spain from Vera Cruz, he sailed northward with the Gulf Stream for a number of days before turning east toward Europe. This same Alaminos was pilot of Ponce de Leon's expedition of 1513 when the Gulf Stream was first noted. It is therefore quite proper to credit the discovery of the Gulf Stream to Alaminos.

Earliest Gulf Stream Chart

For two and a half centuries following its discovery the growth of knowledge regarding the Gulf Stream was slow. The story is told in detail by Kohl[4] and more briefly by Pillsbury. During this period, to be sure, the mariner and more especially the whaler became acquainted with the Gulf Stream throughout the greater part of its course. Much of this information, however, was kept as a professional secret, and it was not until after the middle of the eighteenth century that the course of the current was depicted on a chart. The story of how this came about is not without interest, especially as it illustrates nicely the effect of the Gulf Stream on navigation.

About 1770 complaint was made to the London officials that the English packets which came to New York took about two weeks longer in crossing than did the Rhode Island merchant ships which put in at Narragansett Bay ports. Benjamin Franklin, being in London at the time, was consulted about the matter. To quote his own words:

> It appearing strange to me that there should be such a difference between two places, scarce a day's run asunder . . . I could not but think the fact misunderstood or misrepresented. There happened then to be in London, a Nantucket sea-captain of my acquaintance, to whom I communicated the affair. He told me he believed the fact might be true; but the difference was owing to this, that the Rhode-Island captains were acquainted with the gulf stream, which those of the English packets were not . . . When the winds are but light, he added, they are carried back by the current more than they are forwarded by the wind . . . I then observed that it was a pity no notice was taken of this current upon the charts, and requested him to mark it out for me, which he readily complied with, adding directions for avoiding it in sailing from Europe to North-America.[5]

Franklin goes on to relate that he had the information engraved "on the old chart of the Atlantic, at Mount and Page's, Tower-hill; and copies were sent down to Falmouth for the captains of the packets who slighted it however; but it is since printed in France, of which edition I hereto annex a copy." (Fig. 1.)

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[4] J. G. Kohl: Geschichte des Golfstroms und seiner Erforschung von den ältesten Zeiten bis auf den grossen amerikanischen Bürgerkrieg, Bremen, 1868, pp. 1–114.

[5] A letter from Dr. Benjamin Franklin, to Mr. Alphonsus le Roy, Member of Several Academies, at Paris: Containing Sundry Maritime Observations, *Trans. Amer. Philos. Soc.*, Vol. 2, 1786, pp. 294–329; reference on pp. 314–315.

As evidenced by Franklin's letter in the *Transactions of the American Philosophical Society*, the Gulf Stream towards the end of the eighteenth century became a subject of scientific investigation and discussion. Franklin himself made observations on the temperature of the sea water during a number of voyages and noted with regard to the Gulf Stream "that it is always warmer than the sea on each side of it." By the middle of the nineteenth century, when systematic observations were begun, a fund of information had been gathered from navigators' logs and from the observations of scientifically-minded travelers.

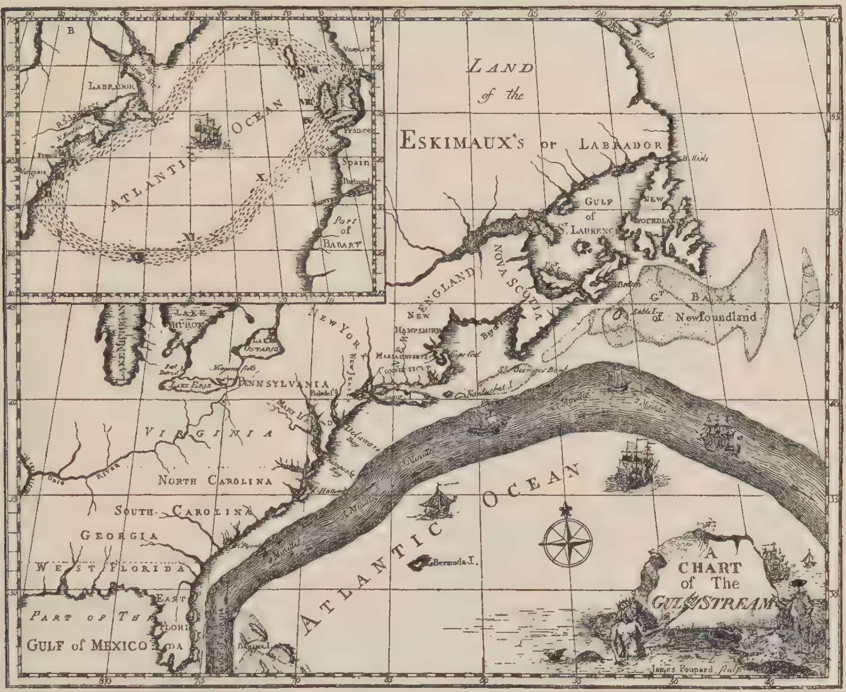

FIG. 1—Franklin's chart of the Gulf Stream.

SYSTEMATIC OBSERVATIONS

Systematic observations in the Gulf Stream were begun in 1845 by the Coast Survey under the superintendency of Alexander Dallas Bache, a grandson of Franklin. At different times up to the year 1889 specially equipped vessels were detailed for the work, the results being published as appendixes to the annual reports of the Superintendent of the Coast and Geodetic Survey, the last one being that by Pillsbury cited in footnote 2. In passing, it is to be noted that this systematic work was confined almost wholly to the Gulf Stream along the coast of the United States.

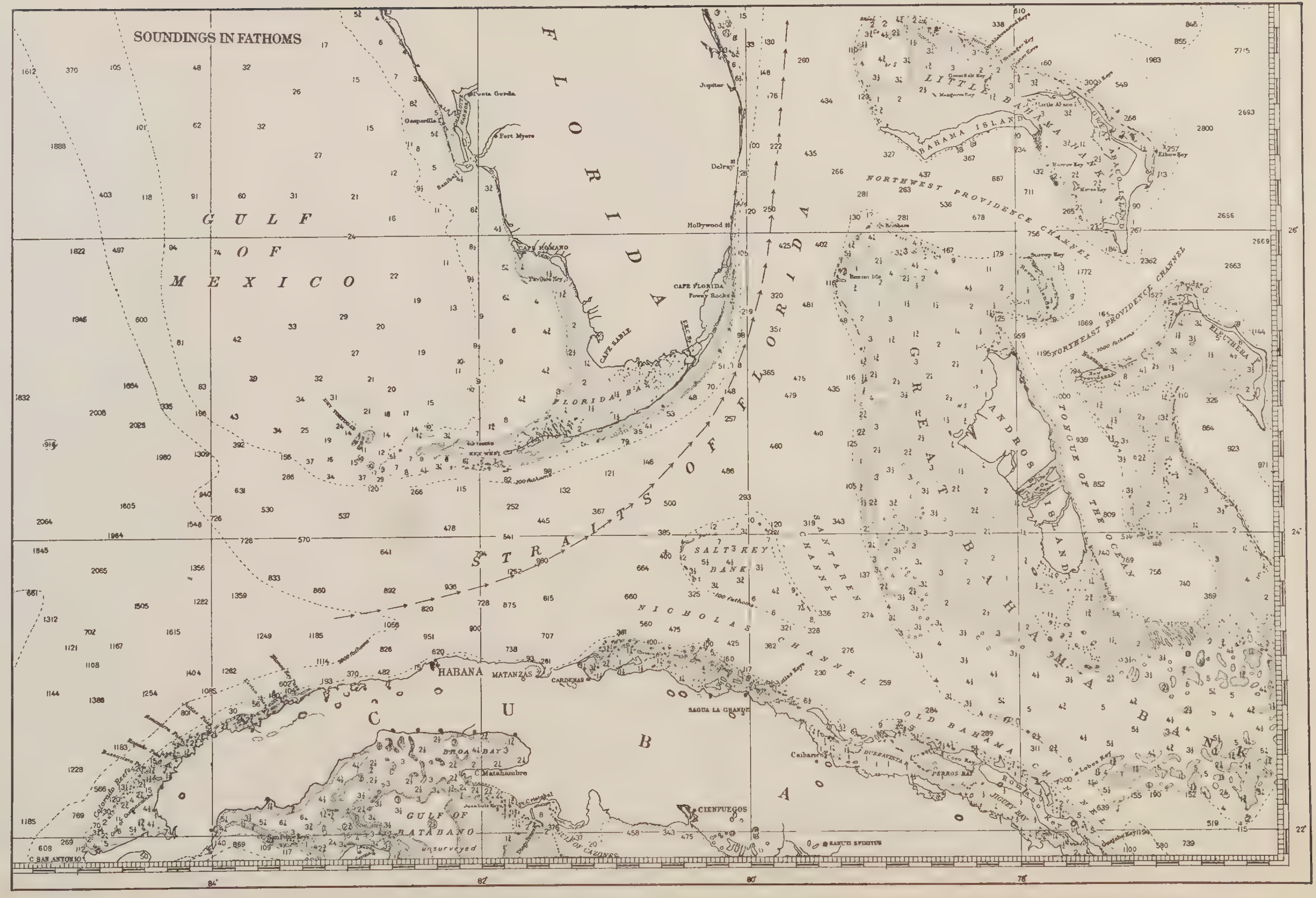

FIG. 2—Hydrographic features of the Gulf Stream within the Straits of Florida. (Adapted from *U. S. Coast and Geodetic Survey Chart 1007.*)

The published material on the Gulf Stream is extensive. Here it will be sufficient to direct attention only to the more authoritative recent work. Krümmel, in what is still the standard textbook of oceanography,[6] gives a brief but critical summary of the hydrographic features of the Gulf Stream as developed to the end of the first decade of the present century, and Schott[7] brings the discussion up to the present time. And, while dealing with but a restricted part of the Gulf Stream, Wüst's study[8] should be mentioned here because it represents a successful attempt to correlate and elucidate the phenomena involved in the Gulf Stream by means of mathematical, or more accurately perhaps, dynamical methods.

It is customary to trace the last remnant of the Gulf Stream into the Arctic waters north of Norway. From its place of origin in the Gulf of Mexico, therefore, this current traverses a route of more than six thousand miles. But it is not as a "river in the ocean" that it manifests itself throughout its course. The phenomena presented are much more involved, and the Stream is to be regarded rather as a complex system of currents than as a single current. We may arrive at an understanding of the nature of the forces and factors involved by a brief consideration of its characteristics in the region in which it has been most carefully studied.

The Current in the Straits of Florida

It is in its first reach, through the Straits of Florida, that the characteristics of the Gulf Stream are most marked. Here its waters have the highest temperature and salinity and the swiftest flow. And because it is here confined within a restricted channel it lends itself more readily to investigation. Observations have here been made across a number of sections; and with this stretch, too, Wüst's study mentioned above is concerned.

Figure 2, which is adapted from Coast and Geodetic Survey Chart 1007, visualizes the hydrographic features of the Gulf Stream for the first 400 miles of its course. The region where the Gulf of Mexico narrows to form the channel between Florida Keys and Cuba may be regarded as the head of the Gulf Stream. Here the width of its channel is 95 nautical miles. Eastward the channel becomes narrower, reaching its least width in the so-called Narrows, abreast of Cape Florida, where it is but half its original width. From here it widens somewhat until it meets the open sea north of Little Bahama Bank.

While the chart shows that in its first reach the Gulf Stream flows between banks like a river, it is to be noted that this channel is in two respects markedly different from that of a river. In a river, as a rule, the channel increases in width from head to mouth. But in the Gulf Stream, as we have just seen, the width of the channel decreases seawards. Furthermore, a river deepens as it goes seaward; an examination of the chart, however, shows that the channel of the Gulf Stream becomes shallower as it goes seaward. At its head, as shown in Figure 2, the Stream shows depths of a thousand fathoms or more; but the depths gradually decrease, and when the channel approaches the sea the greatest depth is but little more than 400 fathoms.

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[6] Otto Krümmel: Handbuch der Ozeanographie, 2 vols., Stuttgart, 1907–1911.

[7] Gerhard Schott: Geographie des Atlantischen Ozeans, 2nd edit., Hamburg, 1926, pp. 180–205.

[8] Georg Wüst: Florida- und Antillenstrom, *Veröffentl. Inst. für Meereskunde*, No. 12, 1924, Berlin.

Nautical charts are issued primarily for the mariner, to whom the shoal areas are critical. Hence in hydrographic surveys, as a rule, shoal areas are much more closely developed than areas of deep water. So that it may be assumed that the relief of the bottom of the Straits of Florida is indicated only in its larger features on the chart. It is quite likely that a detailed hydrographic survey of the Straits would bring out interesting local features that now are masked.

Throughout the whole stretch of four hundred miles shown in Figure 2, the Gulf Stream flows with considerable velocity. It is clear, however, that the whole mass of water is not moving with a uniform velocity. Confining our attention for the present to the velocity of the current at the surface we find at its head, say abreast of Havana, the velocity in the axis of the stream (shown by arrows in Figure 2) to be about 2½ nautical miles per hour, or 2½ knots on the average. Seaward, the velocity increases gradually as the cross-sectional area of the Stream decreases until abreast of Cape Florida the velocity becomes about 3½ knots. As we shall see later, the current is subject to variations; and it is therefore to be emphasized that the velocities given above are approximate average or normal velocities.

With regard to the current within the depths of the Gulf Stream the observational data are in general fragmentary. Pillsbury during his investigation carried out several series of current observations in the Straits of Florida, but these were generally confined to depths less than 1000 feet. From these observations and from general considerations it is known that the swiftest thread of the current lies in the axis of the Stream, just below the surface, and from here the velocity decreases with increasing depth. In the axis of the Gulf Stream, off Havana, Pillsbury found the current setting easterly with a velocity of a knot at a depth of 130 fathoms.

Within the narrows of the Strait, abreast of Cape Florida, the velocity distribution may be considered relatively well known. Figure 3, adapted from Wüst, shows the velocity distribution across the section just south of Cape Florida. In constructing the velocity curves Wüst made use of Pillsbury's observations; and for the deeper parts, for which no observations are at hand, he derived the necessary data from a consideration of the temperature and salinity observations, which here extend from the surface to the bottom.

Within the Straits of Florida the Gulf Stream is generally pictured as a swiftly moving stream with but little variation in velocity from surface to bottom. Figure 3 shows, however, that only within a layer of about 200 fathoms (1200 feet) does the velocity exceed one knot. Moreover, near the bottom, Pillsbury found the current setting southerly, that is in a direction opposite to that of the main stream. This was taken to indicate a southerly flowing current, deriving perhaps from the Labrador Current. It appears, however, that it is more reasonably to be ascribed to eddies brought about by the upward-sloping bottom within the Straits of Florida.

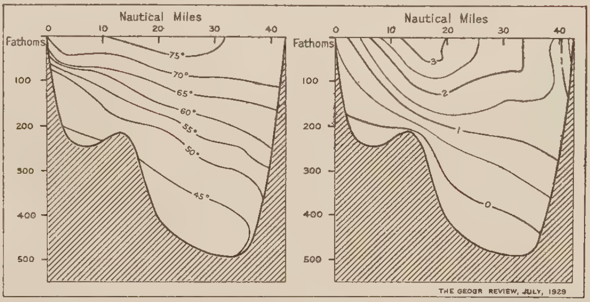

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FIG. 3—Cross sections showing the temperature (left) and velocity (right) of the Gulf Stream waters within the Straits of Florida. (After Wüst.)

With the details of the velocity distribution known, it becomes possible to compute the volume of water discharged by the Gulf Stream through the Straits of Florida. A rough estimate is easily made from Figure 3. In round numbers the channel eastward of Cape Florida has a width of 42 (geographical) miles and an average depth of 2000 feet, or approximately one-third of a mile. This gives the area of the cross section here as 14 square miles. In round numbers, also, the velocity of the current through this section may be taken as one knot. Each hour, therefore, the Gulf Stream carries 14 cubic miles of water past this section into the sea. Since a geographical mile has a length of 6080 feet and a cubic foot of sea water weighs approximately 64 pounds, we find that each hour the Gulf Stream carries 100 billion tons of water past Cape Florida into the sea.

The above calculation is clearly no more than a rough estimate; but it demonstrates that the hourly volume of the Gulf Stream is to be reckoned in scores of billions of tons. On the basis of his observations Pillsbury calculated the hourly volume of the Gulf Stream through the Straits of Florida as 90 billion tons. More recently Wüst, on the basis of data furnished by the observations and amplified by dynamical considerations, derived for this volume 89.96 cubic kilometers, or 14.1 cubic miles, which equals 101½ billion tons. In round numbers we may therefore take the average hourly volume of the Gulf Stream through the Straits of Florida to be 100 billion tons.

We may perhaps appreciate better the enormous volume of water that the Gulf Stream pours into the sea by comparing it with the volume discharged by the Mississippi River, which drains more than

40 per cent of the area of continental United States. On the average the Mississippi discharges about 664,000 cubic feet of water into the Gulf of Mexico each second. At extreme flood stage this volume becomes multiplied about threefold, mounting to about 1,800,000 cubic feet per second.[9] On converting these figures into cubic (geographical) miles per hour they become respectively 0.01 and 0.03 cubic mile. The 14 cubic miles which the Gulf Stream hourly pours into the sea is thus more than 1000 times the average discharge and very nearly 500 times the extreme flood discharge of the Mississippi.

The Water Within the Straits of Florida

With regard to the water poured so prodigally by the Gulf Stream into the sea through the Straits of Florida, the generally accepted notion is that it is of an unusually high temperature from top to bottom. Figure 3 shows the temperature of the water, in degrees Fahrenheit, across the section in the Straits from Cape Florida eastward. This is adapted from Wüst, who made use of observations taken in May, 1878, and in March, 1914. Since, in general, the sea in the northern hemisphere is coldest in February and warmest in August, it may be taken that the temperatures shown in Figure 3 are approximately average temperatures.

Obviously the Gulf Stream in the Straits is not a homogeneous body of warm water. At the surface, in the center of the channel, the temperature is about 80°, and at the bottom it is 45° or even less. The fall in temperature is fairly rapid, a temperature of 50° being attained at about 200 fathoms, so that only a relatively shallow layer of the water is warm.

Figure 3 brings to light the fact that for any given depth the water on the eastern side of the channel is considerably warmer than that on the western. Thus at a depth of 100 fathoms the water on the Florida side of the Straits has a temperature of about 50°, while on the Bahama side the temperature is about 70°. Furthermore, while the change in temperature with depth is approximately uniform on the Bahama side, it is decidedly non-uniform on the Florida side, where a rapid change of 20° in temperature takes place between the depths of 50 and 100 fathoms. As regards temperature therefore, the water of the Gulf Stream is decidedly not homogeneous.

The prevailing conception of the Gulf Stream as an unusually warm body of water can be shown as erroneous from another point of view; namely, by comparison with other bodies of water in the same latitude, for example, with the Sargasso Sea. The surface waters of the Gulf Stream in the Straits of Florida have about the same temperature as the surface waters of the Sargasso Sea. But within the depths the Sargasso Sea is much warmer. At a depth of 200 fathoms the temperature of the latter is between 60° and 65°[10], while in the Gulf Stream at that depth the temperature, as shown by Figure 3, averages about 55°.

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[9] J. L. Greenleaf: The Hydrology of the Mississippi, *Amer. Journ. of Sci.*, Ser. 4, Vol. 2, 1896, pp. 29–46; reference on p. 42.

With regard to other characteristics there is a like tendency to overrate the waters of the Gulf Stream. Highly saline these waters are, but not exceptionally so. On the customary salinity scale, in which each unit represents one part of salt in a thousand parts of water, the surface waters within the Straits have a salinity of about 36. Below the surface the salinity increases gradually until a maximum of 36½ is reached at a depth of about 100 fathoms, after which the salinity decreases to about 35 at 300 fathoms, which salinity is then maintained to the bottom. In round numbers we may take the salinity of the waters within the Straits as a whole to be 36. Compared to the average salinity of 34¾, which is accepted as the figure for the sea as a whole, the water within the Straits is highly saline; but toward its eastern end the Sargasso Sea is more saline, having a salinity of 37½ on the surface and of about 36 at a depth of 300 fathoms. In depth of color and transparency the waters in the Sargasso Sea likewise exceed those of the Gulf Stream.

In general, however, the Gulf Stream as it issues into the sea through the Straits of Florida may be characterized as a swift, highly saline current of blue water whose upper stratum is composed of warm water.

Union with the Antilles Current

On issuing into the sea north of Little Bahama Bank the Gulf Stream loses the relatively great velocity which characterized it within the Straits. From 3½ knots along the axis within the narrows of the Straits there is a gradual decrease to a velocity of about two knots off St. Augustine, Fla., in latitude 30° N. Here the Gulf Stream is joined by the Antilles Current, which flows northwesterly along the open ocean side of the West Indies before uniting with the Gulf Stream.

North of the thirtieth parallel of latitude, therefore, the Gulf Stream is a current to which two branches have contributed. It is no longer merely a continuation of the current that flows through the Straits of Florida. The latter current, for distinction, is frequently referred to as the Florida Current. As to the relative importance of the two branches of the Gulf Stream widely varying opinions have been entertained. Formerly it was thought that the Antilles Current furnished both the greater quantity of water as well as the greater quantity of heat transported by the Gulf Stream. Krümmel, for example, credits the Antilles Current with contributing about 2¾ times as much water and heat as the Florida Current. Wüst's study of the question, however, makes it appear that the rôles of the two currents must be reversed; for he finds, on the basis of later data, that the Florida Current contributes about twice as much water and heat as the Antilles Current.

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[10] Schott, *op. cit.*, Pl. XIV, following p. 144.

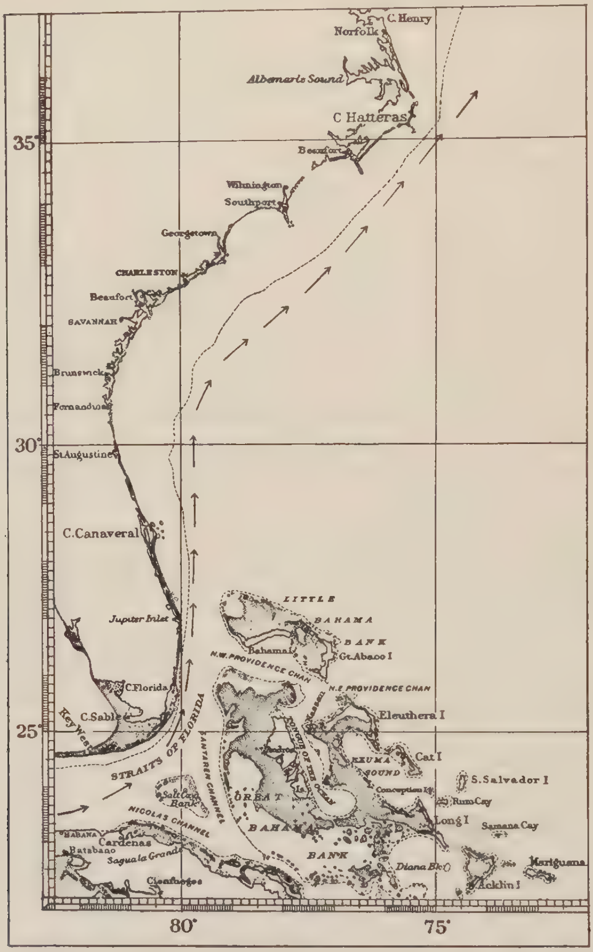

Fig. 4—The axis of the Gulf Stream. The dotted line represents the 100-fathom line.

The Antilles Current, like the Florida Current, carries warm, highly saline water of clear indigo blue. The union of the two currents gives rise to a broad current possessing about the same characteristics as the Gulf Stream within the Straits except that the velocity is much reduced. The combined current under the influence of the deflecting force of the earth's rotation and the easterly-trending coast line turns more and more easterly, so that off the coast of Georgia the Gulf Stream bears northeast, maintaining this general direction past Cape Hatteras.

The Axis of the Stream

From within the Straits the axis of the Gulf Stream runs approximately parallel with the 100-fathom curve as far as Cape Hatteras, a distance of about 800 geographical miles. Since this stretch of coast line sweeps northward in a sharper curve than does the 100-fathom line, the axis lies at varying distances from the shore. Within the

Straits it is about 10 miles off shore; in the bight off the coast of Georgia this distance is about 100 miles; and at Cape Hatteras it is about 35 miles. In Figure 4 the axis is shown as compiled from Coast and Geodetic Survey Charts 1007 and 1001 and Hydrographic Office Chart 1411. On these charts the axis bears the following legends: "approximate axis of maximum strength" (Chart 1001); "approximate location of axis of Gulf Stream" (Chart 1007); "mean position of axis of Gulf Stream" (Chart 1411).

Even with a qualifying phrase directing attention to the fact that it is only approximate, the axis of the Gulf Stream as it appears on a chart tends to convey a sense of definiteness and precision wholly at variance with the observed facts. The channel of the Gulf Stream is so wide and is characterized by so many irregularities that the simple flow postulated can be but the roughest approximation.

Strictly, we should distinguish between the temperature axis and the velocity axis of the Gulf Stream. The earlier systematic observations on the Gulf Stream dealt with the temperature of the water rather than with its motion. Hence the axis was taken to be the line along which the highest temperatures obtained. Later, the axis was taken to mark the line of greatest velocity. Ordinarily it is assumed that the two axes coincide; but this is by no means certain, and only systematic observations over a considerable period can solve this problem.

Lateral Boundaries

Within the Straits the lateral boundaries of the Gulf Stream can be fixed with considerable precision. But when the Stream issues into the sea, how are these boundaries to be determined? On the western side, to be sure, it is not difficult to define limits, since the waters of the Stream differ in color, temperature, salinity, and flow from the inshore coastal waters. But on the east the Antilles Current comes to reënforce the Gulf Stream, so that its waters here merge gradually with the waters of the open Atlantic. In terms of color, temperature, and salinity it would be difficult to define the eastern limits of the Gulf Stream. With regard to direction of flow, however, we may fix the limits to include all the water flowing parallel to the axis. These limits vary with the seasons and with changing conditions of wind and weather. Furthermore, our knowledge of currents in the open sea is not yet sufficient to enable us to fix such limits with precision. Nevertheless, from such charts of the currents of the Atlantic as Schott's[11] and Meyer's[12] we may arrive at some approximately accurate estimate of the lateral extent of the Gulf Stream.

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[11] *Ibid.*, Pl. XV, following p. 144.

[12] H. H. F. Meyer: Die Oberflächenströmungen des Atlantischen Ozeans im Februar, *Veröffentl. Inst. für Meereskunde*, No. 11, 1923, Berlin.

It has generally been taken that the inner edge of the Gulf Stream, from its outfall into the sea to Cape Hatteras, is defined by the 100-fathom curve. But recent observations by the Coast and Geodetic Survey indicate that it lies closer inshore. Systematic current observations made on board Diamond Shoals Light Vessel, which is anchored in 30 fathoms of water off the coast of North Carolina about 14 miles southeast of Cape Hatteras, give an average surface current here of 0.4 knot setting N. 58° E., which proves that along this stretch of the coast the inner edge of the Gulf Stream lies nearer the 20-fathom curve than the 100-fathom curve. Taking the inner limit of the Gulf Stream as far as Cape Hatteras to be defined by the 50-fathom curve, and the outer edge to be defined by a line along which the current is still approximately parallel to the axis of the Gulf Stream, the width of the Stream northward of its outfall is as follows: off Cape Canaveral about 70 miles; off the coast of Georgia after its union with the Antilles Current about 150 miles; off Cape Hatteras about 200 miles.

Conflict with the Labrador Current

The region off Cape Hatteras has been called the "delta" of the Gulf Stream, for here the widespreading current separates into a number of bands. This is most clearly evidenced by the juxtaposition of warm and cold bands of water of varying widths. This feature is also noted below Cape Hatteras but not in so marked a degree.

North of Cape Hatteras the Gulf Stream flows with a velocity averaging a little less than a knot, turning more and more eastward under the combined effects of the deflecting force of the earth's rotation and the eastwardly trending coast line, until the region of the Grand Bank of Newfoundland is reached. Here it comes into conflict with the southerly flowing Labrador Current which carries cold water of relatively low salinity.

The Cold Wall

At an early stage of the investigations it was found that on its western or inner side the Gulf Stream was separated from the coastal waters by a zone of rapidly falling temperature, to which the term "cold wall" was applied. It is most clearly marked north of Cape Hatteras but extends, more or less well defined, from the Straits to the Banks of Newfoundland. The abrupt change in the temperature of the waters separated by the cold wall is frequently very striking. Ward refers to an occasion in 1922 when the U. S. Coast Guard Cutter *Tampa*, which is about 240 feet long, was placed directly across the cold wall, and the temperature of the sea at the bow was found to be 34° while at the stern it was 56°.[13]

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[13] R. DeC. Ward: A Cruise with the International Ice Patrol, *Geogr. Rev.*, Vol. 14, 1924, pp. 50–61; reference on p. 54.

In the vicinity of the Banks of Newfoundland the cold wall represents the dividing line between the warm waters of the Gulf Stream and the cold waters of the Labrador Current; and it seemed reasonable to invoke the cold waters of this current in explaining the existence of the cold wall and the relatively low temperatures of the coastal waters to the southward and westward. It was largely on this account that the waters of the Labrador Current were assumed to flow all along the eastern coast of the United States.

Recent observations, however, do not bear out this explanation. Current observations on various light vessels along the Atlantic Coast of the United States made in recent years by the Coast and Geodetic Survey give no evidence of a predominant southerly movement of the water along the coast. From the observations made by the International Ice Patrol, Smith concludes that there is no southwest flow of the Labrador Current across the Great Bank, but that it "turns sharply, between parallels 42 and 43 and meridians 51 and 52, to flow easterly, parallel with the Gulf Stream."[14] In his study of the Gulf of Maine, Bigelow gave careful consideration to this question. His conclusion is that he has "no hesitation, therefore, in definitely asserting that the Labrador Current does not reach, much less skirt, the coast of North America, from Nova Scotia southward, as a regular event."[15]

Several agencies appear to be responsible for the cooler coastal waters along the eastern coast of the United States. In the first place into this area the rivers bring their drainage waters from the land, these waters being for the greater part of the year much colder than the open ocean waters. Another contributory cause is the deflection by the earth's rotation of cold water from the Gulf of St. Lawrence against the American coast. Then, too, the coastal waters are closer to the low winter temperatures of the land and are thus made colder than the open ocean waters. A further cause is found in the winds, which along the coast of the United States are prevailingly from the land. This tends to drive the warmer surface water seaward, its place being taken by the cooler subsurface waters.

The North Atlantic Drift

When we come to a study of the horizontal circulation of the North Atlantic Ocean we find a complex system of interrelated currents, as is evident from a glance at Figure 5. In this figure, which is adapted from Schott, three characteristics of the currents are indicated. The direction of the current at any point is shown by the direction of the arrow at that point; the strength of the current or its velocity is indicated by the width of the arrow; and the stability of the current is indicated by the length of the arrow. The stability of the current at any point is expressed as a percentage and is a measure of the constancy of direction of the current at that point. The derivation of the numerical value of the stability involves technical details[16] which need not detain us here.

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[14] Edward H. Smith: Oceanographic Summary, in "International Ice Observation and Ice Patrol Service in the North Atlantic Ocean, Season of 1922," *U. S. Coast Guard Bull. No. 10*, Washington, 1923, pp. 93–97; reference on p. 97.

[15] H. B. Bigelow: Physical Oceanography of the Gulf of Maine, *U. S. Bur. of Fisheries, Doc. No. 969*, Washington, 1927, p. 828. See also H. B. Bigelow: Exploration of the Waters of the Gulf of Maine, *Geogr. Rev.*, Vol. 18, 1928, pp. 232–260.

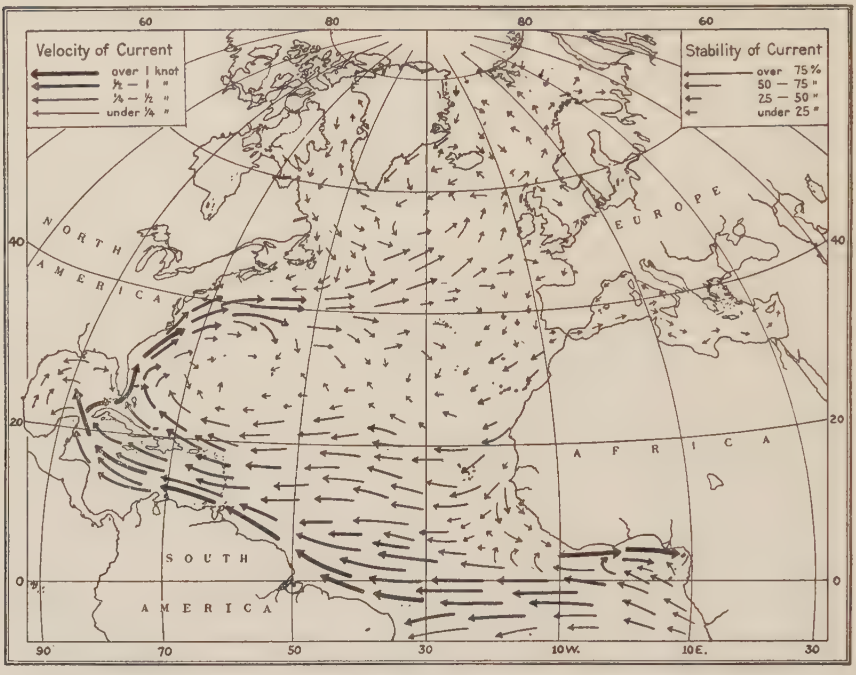

FIG. 5—Surface currents of the North Atlantic Ocean. (After Schott.)

In a very real sense the circulation indicated by Figure 5 constitutes a single current system; for a movement of the water at any point implies corresponding movements and return currents at other points, all these movements together forming a system of circulation. However, the large area covered by the North Atlantic Ocean and more particularly the different characteristics of the moving masses of water as regards temperature, salinity, and velocity make it convenient to designate various parts of the system by distinctive names, as for example the North Equatorial Current or Canary Current.

Starting at any given point various circuits may be traced on a current chart. The one which, under the name of Gulf Stream, we have followed from the Straits of Florida as far as the Banks of

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[16] Krümmel, *op. cit.*, Vol. 2, p. 441.

Newfoundland may be traced further eastward and northeastward to the coastal waters of northwestern Europe, as shown in Figure 5. Shall this current circuit from the eastern coast of the United States to northwestern Europe be designated by the single name Gulf Stream? Or shall we limit the name Gulf Stream to the stretch from the Straits to the Banks of Newfoundland, since in this stretch the characteristics of the current are much the same? If it is the northeasterly transport of warm water across the Atlantic that one has in mind, a single name like Gulf Stream or North Atlantic Current has many advantages. If, however, the causes and details of the movement of the water are being studied, the phenomena are more clearly apprehended by giving the current eastward of the Banks of Newfoundland some such name as Gulf Stream Drift or North Atlantic Drift. It is a slow current, the velocity averaging less than half a knot, and its movement is due in large part to the westerly winds which prevail over this stretch of the ocean.

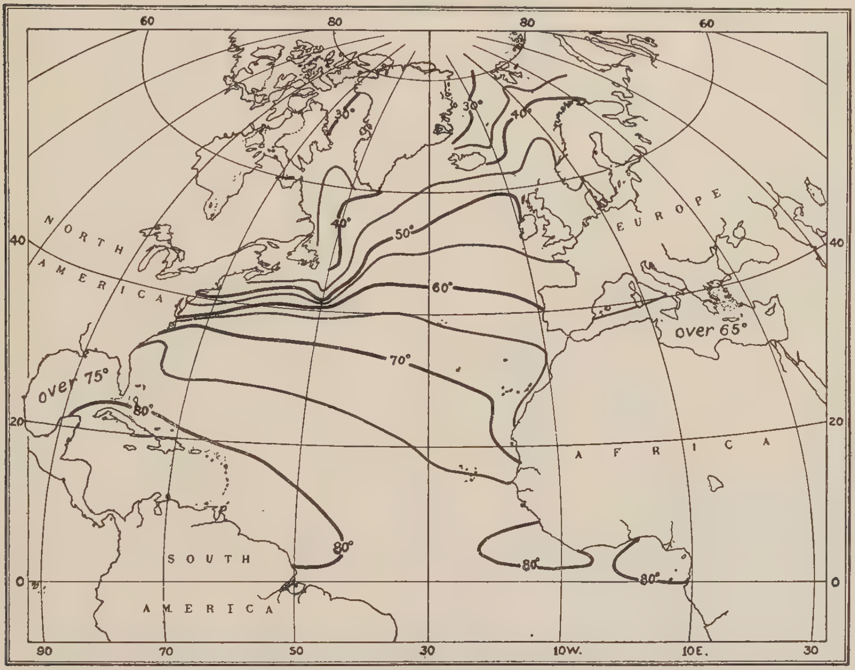

FIG. 6—Isotherms of the surface waters, North Atlantic Ocean. (Adapted from Schott.)

The validity of the conception underlying the representation of the movement of the waters in the Gulf Stream and in the North Atlantic Drift by current charts like Figure 6 has been assailed in recent years by Dr. E. Le Danois. In a paper published in 1924[17] he elaborates the thesis that the movement of the waters of the North Atlantic consists of two currents—a circumpolar current and an equatorial current—and various so-called transgressions, by which name he denominates slow periodic movements of the water of the nature of long-period tidal movements. The Gulf Stream in particular he reduces to a mixture of the equatorial current with the tidal current from the Gulf of Mexico, which tidal current he mentions as being violent. "This tidal current—the true Gulf Stream—is compelled to move into the open sea by the presence of the last waters of the Labrador Current which skirt the coast of the United States" (p. 19).

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[17] E. Le Danois: Étude hydrologique de l'Atlantique-Nord, *Annales Inst. Océanographique*, Vol. 1 (N. S.), 1924, pp. 1–52.

Now there are data at hand, as we shall see later, which completely disprove the existence of violent tidal currents in the Gulf of Mexico. Moreover, in characterizing the current in the Straits of Florida as a tidal current Le Danois must have in mind something quite different from what is commonly understood by the term, namely, a periodic forward and backward movement of the water with a period of half a day or a day. And in invoking the presence of the Labrador Current along the coast of the United States he surely does not strengthen his case; for, as we have seen, the view that the Labrador Current reaches the coast of the United States is no longer tenable.

The reality of the movement of the water from the lower latitudes of the western North Atlantic to the higher latitudes of the eastern North Atlantic is not only evidenced by a chart of the currents but is also clearly indicated by the temperature of the surface waters. In Figure 6 the isotherms of the surface waters of the North Atlantic are shown for each five degrees Fahrenheit. The northerly sweep of the isotherms in the eastern North Atlantic points clearly to the existence of a current moving easterly and northerly across this oceanic basin.

Causes of the Gulf Stream

Ocean currents may arise from any one or more of a number of causes. Some of these causes reside within the sea itself, others originate without. Differences in level between two regions of an ocean basin, brought about by whatever agencies, will result in a surface current from the higher to the lower level. Differences in density, whether arising from difference in temperature or in salinity or both, will bring about a subsurface current from and a return surface current to the region of greater density. Differences in atmospheric pressure between two regions will, in the same way, bring in their train a subsurface current from and a return surface current to the region of greater pressure. And in the wind we have at once the most obvious and the most familiar of the agencies that bring about ocean currents.

In a current traversing so long a course as that of the Gulf Stream it is plain that all the agencies enumerated above enter as factors.

Clearly, too, the relative importance of the different agencies must vary in different parts of the course. But various problems of an hydrodynamic character must yet be solved before a numerical evaluation of the relative importance of the agencies concerned in the movement of the Gulf Stream is possible.

A century and a half ago Franklin thought that the Gulf Stream "is probably generated by the great accumulation of water on the eastern coast of America between the tropics, by the trade winds which constantly blow there." And in the trade winds, which bring about a westerly flow of the waters in the equatorial regions of the Atlantic Ocean, is still found the primary cause of the Gulf Stream. As appears from Figure 5, the waters of the South Equatorial Current are the first to strike the coast, the greater part being directed northwestward into the Caribbean Sea where they reënforce the flow of the North Equatorial Current. From the Caribbean the combined flow comes into the Gulf of Mexico whence it issues as the Gulf Stream into the Straits of Florida.

Now while the Gulf Stream is traced to the trade winds, the Stream is not a wind or drift current as are the North and South Equatorial Currents. The accumulation of water resulting from the trade winds brings about a gradient current. This means that a higher level of the water must obtain in the Gulf of Mexico than out in the open sea north of the Straits of Florida. Agassiz quotes Hilgard as regarding the Gulf of Mexico "as an immense hydrostatic reservoir rising to the height of more than three feet above the general oceanic level, and from this supply comes the Gulf Stream, which passes out through the Straits . . . the only opening left for its exit."[18] And in a footnote he adds, "By a most careful series of levels, run from Sandy Hook and the mouth of the Mississippi River to St. Louis, it was discovered that the Atlantic Ocean at the first point is forty inches lower than the Gulf of Mexico at the mouth of the Mississippi." In a paper published in 1914 Hepworth states, "As regards the Gulf Stream, and its causation, it was found by the officers of the United States Coast Survey that the Atlantic ocean at Sandy Hook was 3 to 4 feet lower than the waters of the Gulf of Mexico at the mouth of the Mississippi."[19]

It should be remembered that leveling of even the highest precision is subject to instrumental errors which, while very small for moderate distances, may become relatively large between widely separated points. More recent results reduce very much the difference in level between the Gulf of Mexico and the Atlantic and bring to light the fact that this is a highly involved matter. Avers recently studied this question in connection with the broader question of the deviations of local sea level from a level surface.[20] His results, which are based on the best available data, may be summarized as follows. From Galveston, Texas, to Cedar Keys, on the west coast of Florida, the level of the Gulf slopes downward, the difference between the two places being 0.43 foot. The level of the Gulf at Cedar Keys is 0.36 foot higher than the level of the Atlantic Ocean at St. Augustine on the eastern coast of Florida. But from St. Augustine northward there is an upward slope of sea level all along the Atlantic coast of the United States; so that in the vicinity of Sandy Hook sea level is actually 0.62 foot higher than at St. Augustine and but 0.16 foot below the Gulf level at Galveston.

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[18] Alexander Agassiz: Three Cruises of the United States Coast and Geodetic Survey Steamer "Blake" (2 vols., Boston and New York, 1888), Vol. 1, p. 249.

[19] M. W. Campbell Hepworth: The Gulf Stream, *Geogr. Journ.*, Vol. 44, 1914, pp. 429–452 and 534–553; reference on p. 435.

This upward slope of sea level along the Atlantic coast of the United States does not necessarily mean that the Gulf Stream is moving uphill. For the main body of the Gulf Stream is a number of miles off the coast, and there may well be a downward slope of sea level outward from the coast. The question of sea level itself is one complicated by many factors, and the exact determination of the difference in level between the Gulf and the open sea bristles with numerous unsolved problems.

Fluctuations of the Gulf Stream

The Gulf Stream manifestly must be subject to fluctuations as regards location, velocity, and temperature. Heavy winds will not only carry its waters into regions which at other times it does not invade but will also accelerate or retard its velocity. Variations in barometric pressure likewise will bring about fluctuations in the movement of the waters of the Stream. Seasonal variations in temperature in the regions through which it flows will be reflected in somewhat similar seasonal variations in the temperature of its waters. A further cause for its fluctuation is found in the fluctuations of the currents which feed it or which, like the Labrador Current, come into conflict with it.

Fluctuations in the velocity of the Gulf Stream are noted by Pillsbury. He refers to an occasion, while he was at anchor in the Straits of Florida, when the velocity of the current at the surface increased from 3.3 knots to 4.6 knots in less than an hour. He speaks, too, of "a regular *daily variation* in velocity which amounts in some instances to nearly 2½ knots" (p. 546). This regular daily variation he regarded as of the nature of a tidal effect. His observations were later subjected to harmonic analysis by Harris, who found the principal constituent of the tidal current to have a velocity of less than a quarter of a knot.[21]

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[20] H. G. Avers: A Study of the Variation of Mean Sea-Level from a Level Surface, *Bull. Natl. Research Council, No. 61* (= *Trans. Amer. Geophys. Union, 1927*), Washington, 1927, pp. 56–58.

[21] R. A. Harris: Manual of Tides, Part V: Currents, Shallow-Water Tides, Meteorological Tides, and Miscellaneous Matters, *U. S. Coast and Geodetic Survey Rept. for the Year Ending June 30, 1907*, Washington, 1907, Appendix 6, pp. 231–545; reference on pp. 411–412.

The tidal current in the Straits of Florida is therefore of negligible velocity, and the fluctuations noted by Pillsbury are undoubtedly irregularities which accompany the flow of water in large masses.

Pillsbury was also of the opinion that, in addition to this so-called regular daily variation and to fluctuations arising from changes in wind and weather, the Gulf Stream within the Straits of Florida was subject to periodic monthly variations in both temperature and velocity which depend on the declination of the moon. The observations are not, however, sufficiently extensive to settle this question definitely. The reality of such variations is still in question, and it would not be at all surprising if further investigation should disprove any such relationship.

In a paper before the American Meteorological Society on "Temperature Variations in the Gulf Stream in the Straits of Florida, 1917–1921,"[22] Hazel V. Miller presented the results of a study of several thousand readings of surface-water temperature made by observers on the Key West-Havana car ferries across the Straits of Florida for the four-year period 1917–1921. The temperature was found to range from a minimum of about 76° in January to about 86° in September, while variations of as much as 4° from week to week under the influence of a strong wind were noted. A comparison of weekly temperatures with winds brought out clearly immediate and persisting effects of the wind as regards both direction and velocity.

From the nature of the agencies concerned, fluctuations from day to day in the flow and temperature of the Gulf Stream may be taken for granted. Seasonal variations likewise are unquestionable, as are smaller fluctuations from year to year. Vilhelm Pettersson studied the temperature data derived from ships' logs, covering the Gulf Stream up to latitude 33° N., for the fourteen-year period 1900–1913. He found that the temperature of the surface waters varies from year to year, generally by less than 1° but sometimes by more than a degree.[23] Whether these yearly variations are, in large or small part, of a periodic nature is at the present time, for lack of sufficient data, an open question.

The difficulties involved in securing systematic observations on the temperature and flow of the Gulf Stream to determine the nature and extent of its fluctuations are obvious. The observations recorded in navigators' log books furnish valuable information, but such observations are not sufficient of themselves. More hopeful is the slowly growing use of sea-water thermographs aboard ships. From the records furnished by these instruments definite information regarding fluctuations in the temperature of the Gulf Stream waters should result.

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[22] Abstract in *Bull. Amer. Meteorol. Soc.*, Vol. 7, 1926, pp. 87–88.

[23] V. I. Pettersson: Étude de la statistique hydrographique du Bulletin Atlantique du Conseil International pour l'Exploration de la Mer, *Svenska Hydrogr.-Biol. Komm. Skrifter, Hydrografi 1 (N. S.)*, 1926, p. 4.

In the light of the preceding considerations the question of whether there has been any permanent change in the course or in the temperature of the Gulf Stream since it has been known to civilized man, may be answered shortly. Manifestly, without extensive observations which would permit comparisons, no categorical answer can be given. But it is clear that any decided change in an ocean current of the magnitude of the Gulf Stream can come only as the result of extensive changes in such features as the bottom of the ocean, the configuration of the coast line, or the prevailing winds. Since no such extensive changes appear to have taken place, it is highly improbable that any decided change in the course of the Gulf Stream has occurred since it has become known.

Climatic Effects

A host of problems lie covered by the question of the climatic effects of the Gulf Stream. That its warm waters have an ameliorating effect on the lands near which they flow is a strongly held opinion; and now and again schemes are seriously proposed to change the course of the Stream with a view to moderating the winter climate of our northeastern states.

A moment's consideration is sufficient to show that the direct influence of the Gulf Stream on the climate of the greater part of the eastern coast of the United States is altogether negligible. For, aside from latitude, our climate depends mostly on the direction from which the winds come and the force with which they blow. In winter the winds along the northeastern coast of the United States are prevailingly from the northwest, that is from the land. Hence the warm waters of the Gulf Stream lying several hundred miles to the leeward can in no way moderate our winter climate.

These considerations are sufficient also to prove the absurdity of the proposals for changing the course of the Gulf Stream in the interests of a more equable climate. Furthermore, the forces that give rise to the Gulf Stream are of such magnitude that they are not yet amenable to control by man. But even if the Gulf Stream could be brought nearer our shores the climate could be moderated only if the winter winds could be made to blow from the south or the southeast.

Indeed, there are good reasons for believing that if the Gulf Stream were to shift closer to the coast the climate of our northeastern states would become more extreme rather than moderated—colder and more stormy in winter, hotter and more humid in summer. For, with warm air near the coast in winter, a greater flow of air from the northwest would result, bringing severer storms and colder weather. In summer, the winds along the coast are more or less sea breezes, bringing the cooler air from the sea to moderate the heat. With warmer air nearer shore, the sea breezes would become weaker and less frequent, thus giving wider scope for the hot land winds.

While the moderating effect of the Gulf Stream on the climate of North America is negligible, there is no question as to its beneficent effects on the climate of northwestern Europe. Scandinavia and southeastern Greenland face each other across the intervening waters of the Atlantic Ocean along the same parallels of latitude. Contrast the populous and prosperous lands of the one with the bleak and inhospitable shores of the other!

It is to be observed that the tempering influence of the Gulf Stream on the climate of northwestern Europe is effected through the agency of winds. In winter the winds are there prevailingly from the southwest. Blowing over the relatively warm water which the Gulf Stream (using the term as embracing also the North Atlantic Drift) has brought to the northeastern rim of the Atlantic, they carry warm air onto the coast. It is through this mechanism that the heat exchange in winter between the Gulf Stream and the air of northwestern Europe takes place.

How great the influence of the Gulf Stream on the climate of northwestern Europe is, becomes evident from the fact that the average temperature for the month of January in northern Norway is about 45° above the January temperature normal for that latitude.[24] Hammerfest, on the north coast of Norway in latitude 70° 40′ N., well within the Arctic Circle, is an important harbor and sea-fishing center during the winter, while the port of Riga, about 800 miles farther south, is obstructed by ice throughout the season.

Since the climate of northwestern Europe is so strongly influenced by the Gulf Stream, should not fluctuations in the latter find reflection in changes in the climatic conditions of this region? At first glance the differences in temperature of the Gulf Stream from year to year—something like one degree—might appear insignificant in such a connection. But the fact is not to be overlooked that the capacity of water for heat is so great that when a given volume of water gives off the heat represented by a fall of one degree in temperature, a mass of air more than 3000 times that volume will have its temperature raised one degree.

A direct attack on this problem is difficult because of the lack of systematic observations on the temperature and flow of the Gulf Stream. Otto Pettersson studied the temperature variations of the water at several places along the Norwegian coast and found that these variations were reflected by corresponding variations in various climatic phenomena.[25] The problem clearly is a complicated one involving the question of the mutual interaction of ocean and atmosphere. A considerable literature has grown up around this, which is summarized by Helland-Hansen and Nansen.[26]

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[24] J. W. Sandström: Über den Einfluss des Golfstromes auf die Winter-temperatur in Europa, *Meteorol. Zeitschr.*, Vol. 43, 1926, pp. 401–411; reference on p. 401.

[25] Otto Pettersson: Über die Beziehungen zwischen hydrographischen und meteorologischen Phänomenen, *Meteorol. Zeitschr.*, Vol. 13, 1896, pp. 285–318.

One phase of this problem links with the question of long-range weather forecasts. It is a long circuit that is traversed by the Gulf Stream from its place of origin in the subtropical regions to the coasts of northwestern Europe. How long a period intervenes between fluctuations in the Stream and the resultant climatic effects in Europe? This problem, too, cannot yet be attacked directly, because of the lack of systematic observations. Such investigations as have been made show this to be a promising field. Thus Otto Pettersson found that the date when spring plowing could commence near Upsala depended on the temperature of the water of the Atlantic off the coast of Norway about two months previous. Vilhelm Pettersson found that the summer temperature of the water in the region between Newfoundland and Ireland gave an indication of the rainfall in Ireland and Great Britain in the following year.

Obviously the problem of unraveling the relationship between changes in the Gulf Stream and weather conditions several months hence is not a simple one. Climatic conditions in any given region of the North Atlantic result from the interplay of a number of factors. Similarly, the temperature of the Stream at any given time is brought about by the interaction of a number of agencies. Nevertheless it appears that in the study of the fluctuations of the Gulf Stream lies the possibility of long-range weather forecasts for a considerable part of Europe.

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[26] Björn Helland-Hansen and Fridtjof Nansen: Temperature Variations in the North Atlantic Ocean and in the Atmosphere, *Smithsonian Misc. Colls.*, Vol. 70, No. 4, Washington, 1920, pp. 26–51.

NEW ENGLAND

John K. Wright
American Geographical Society of New York

FROM the lonely summit of Monadnock Mountain on a clear autumn day one can look over a large part of southern New England. Eastward, ships off Portsmouth may be seen with a glass; westward, Greylock, about seven miles from the New York line, appears not very distant. Around the base of the mountain spreads a hill country typical of the New England upland, with its varied patchwork of woodland, field, and pasture, punctuated by isolated farmhouses and church spires. Second-growth woodland, however, predominates, covering hillsides, filling valleys, suggesting farms gone back to forest and farm folk departed west or to the cities. A keen eye will also find here and there a group of camps beside a pond, a hotel, a rehabilitated farmhouse, and perhaps will see in them evidence of a gradual but mighty transformation: the coming of the summer people to supply—to the remnant farm and village folk—not only the sources of a prosperity that cannot be wrested from a rocky soil but ideals and ambitions alien to those of their forebears.

Far to the south and east smoky blurs rising over the hills from factory chimneys in Fitchburg and Lowell remind one of another New England—the New England of industry and cities. Yet more distant, Boston's only skyscraper, the tower of the Custom House, may be faintly discerned. Possibly one may think of this as a symbol of the seaport metropolis and of what sea trade has meant in New England's development. On the opposite horizon the long, dark ridge of the Berkshires looms as a barrier that has done much to prevent the seaport metropolis of New England from becoming the main gateway to the United States, a natural frontier that, continued north in Lake Champlain, separates New England in more than a physiographic sense from the rest of the United States and contributes toward its regional and historical unity.

Finally, the climber will look north. Sharply etched against the sky are the White Mountains, pale with freshly fallen snow. Here he will see another symbol, that of the long and early winter, which no less than the nature of the ground has had a part in molding New England character. Possibly, too, he will think of the White Mountains as the outpost of a tract of wilderness stretching far to the northeast across Maine, the forested "wild lands" whose exploitation has created a distinctive type of people and of enterprise.

In the words of Benton MacKaye,[1] Monadnock stands forth as "the emblem of a unified homeland . . . the lofty pivot of an indigenous region and culture, of a sample pattern of the American quiltwork—a point from which to see 'a land' and to contemplate the problems that confront it." From Monadnock's summit the thoughtful observer may sense in the serene expanse of country spread below him something of the complexity, the accelerating pace, and the almost irresistible force of social and economic changes in progress.

RURAL AND URBAN PROBLEMS

Although for more than a century population has been drifting to the cities, of late the problems of rural life and rural depopulation have assumed new aspects. The fringes of the cities with their suburban satellites are creeping outward into the countryside. Encircling each metropolis are zones over which there ebb and flow daily tides of office workers and weekly tides of urban tourists. Since the coming of the automobile these zones have expanded far beyond their former margins, and outside of them there is hardly a rural township in all New England not reached by the seasonal tide of vacationists. Few, if any, parts of New England are left where a man from the city excites the slightest degree of curiosity. This was hardly the case a generation ago. Not only does the urban population overflow the country in periodic migrations, but outward from the cities there is a constant radiation of influences carried by newspaper, by magazine, and through the air, by salesman and reformer, and by the return of farm folks from frequent visits to "town," visits unthought of before the days of the automobile. Contact with city folk and exposure to the rays of urban influence are changing the whole complexion of rural life.

People do not leave the farms for the sole reason that they hope to earn more for less work in the cities or for the sole reason that a rising standard of living makes them long for material comforts denied their ancestors. The toil and hardships of farm life have been lessened and may be further lessened by measures leading to greater material gain from the land; and yet the power of these measures to breed contentment may be wholly neutralized by the hypnotism that the city exerts over the hopes and ambitions of the farmer and his growing sons and daughters. As farm folk become more urban-minded new social concepts spread among them, and their desire to associate more freely with their kind grows more deeply rooted. It is conceivable that automobiles, telephones, and radios increase and do not diminish this desire. We must look beyond questions of dollars and cents if we are to find the roots of the problem of rural depopulation and a way leading toward the regeneration of an agricultural population that will enjoy not only economic stability but intellectual and spiritual harmony with its environment.

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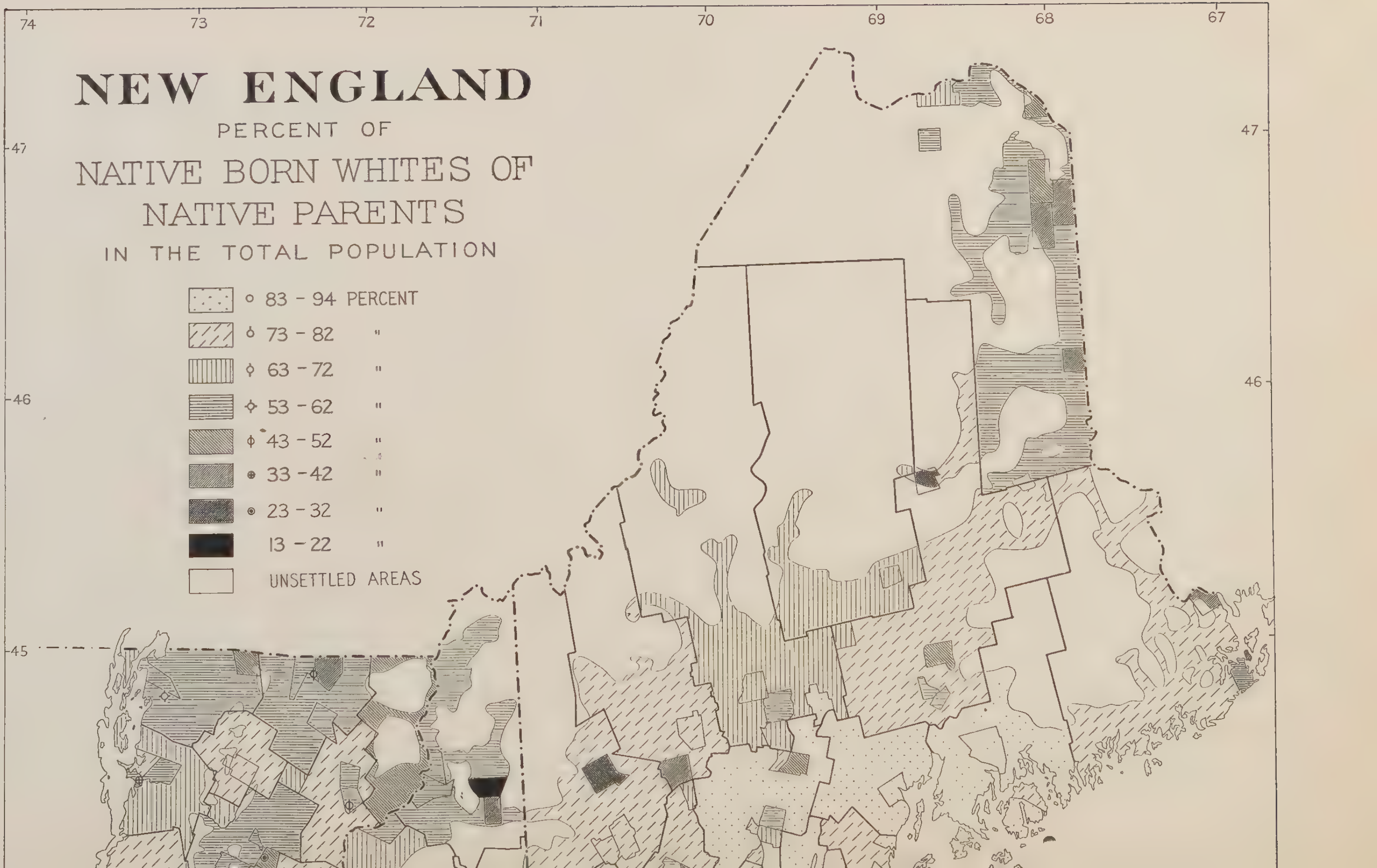
[1] Benton MacKaye: The New Exploration: A Philosophy of Regional Planning, New York, 1928, p. 48. In this stimulating volume a philosophy of regional planning is set forth with special reference to New England.

These problems of rural life are complex and obscure enough, but every candid observer will also admit that there are manufacturing towns and cities in New England where all is not well. The closed factory and decaying wharf tell stories as weighted with meaning as that of the crumbling cellar hole in the pasture. We cannot blink the fact that some of the larger manufacturing towns have actually lost population. This, to be sure, is symptomatic of conditions that may be local and, where they prevail, wholly temporary. The textile business may be on the road to recovery, more industries may be coming to New England than are leaving it. Yet, whether or not pessimists have painted too dark a picture, all will agree that the urban communities of New England are facing grave problems whose solution must not be too long postponed.

Some of the problems are common to urban communities the world over; others grow out of conditions peculiar to New England; still others are local. Questions of overcrowding, of traffic congestion, of inadequate terminal and market facilities, and of power resources may often be solved by measures of local material improvement. Other difficulties originate from the geographical and economic relations of New England to the rest of the country: from the circumstance that New England is off in a corner of the United States, relatively remote from the trunk streams of commerce that flow between the greater centers of production and consumption; from competition of New England factories with factories of the South and the Middle West; from railroad rates that are unfavorable or thought to be so; from regional peculiarities in methods of business and administration that differentiate New England from other parts of the nation. There are also problems arising from the diversified composition of the population and from the conflict of traditions, institutions, and loyalties that springs out of the mingling of races and creeds. Even when factory doors are open, wage envelopes big, and dividends regular, the benefits of material prosperity may be nullified by the tightening of class lines, the crystallizing of racial prejudices, the maladjustment of established institutions to ideals, customs, and ambitions in flux. Under cover of prosperity, moreover, destructive forces may begin their work and, unless watched and deflected, ultimately gain such momentum that no human wisdom can repair their damage.

Search for Solutions

Why point out the obvious? Everybody who knows New England knows that its problems are complex and difficult. The last



NEW ENGLAND

PERCENT OF

NATIVE BORN WHITES OF NATIVE PARENTS

IN THE TOTAL POPULATION

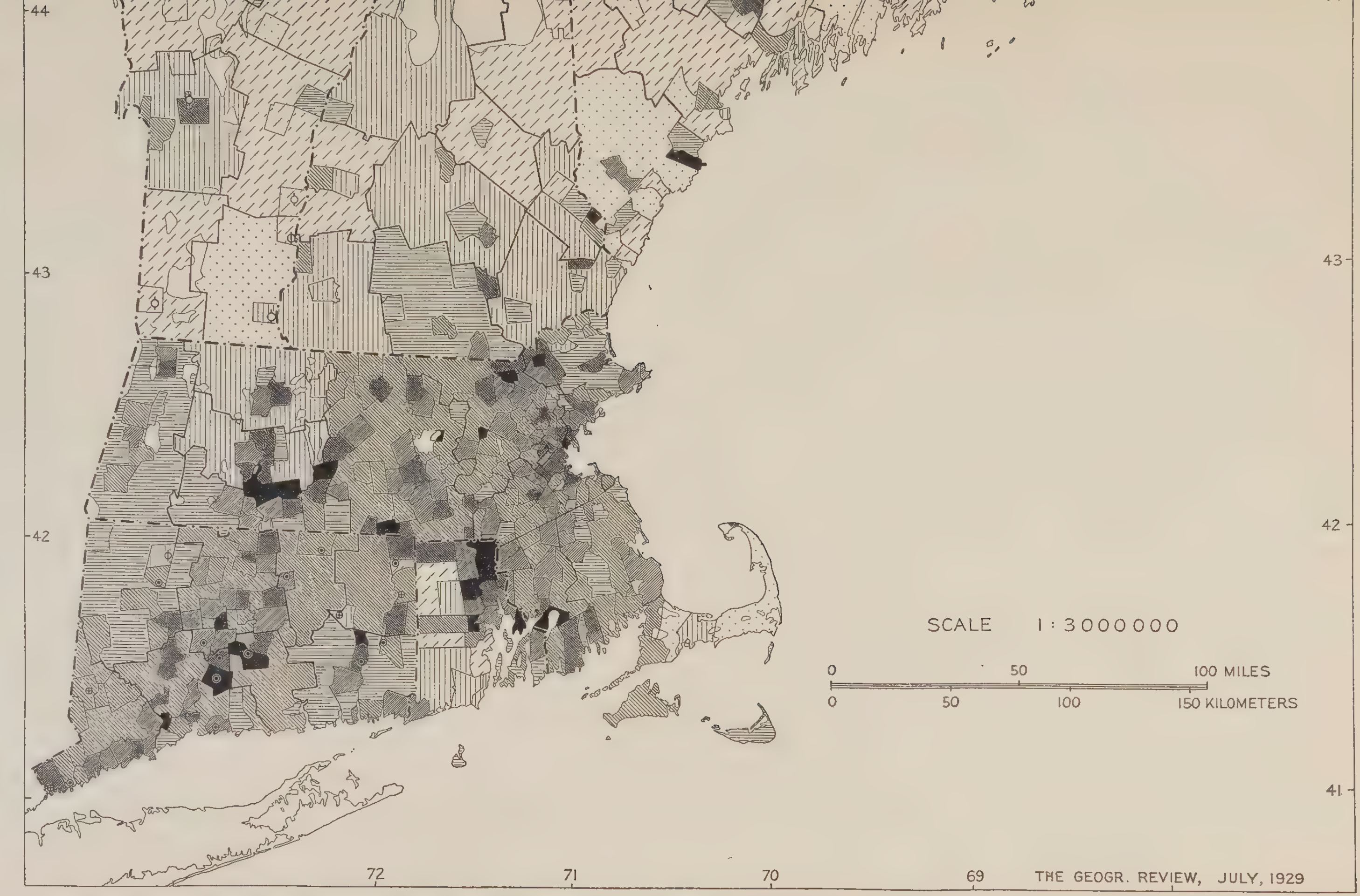


FIG. 1—On this map the lighter the ruled or dotted areas, the more purely "Yankee" is the population (according to the census of 1920). The percentages have been plotted for the smallest areas (wards of cities excepted) for which it is possible to calculate them from the U. S. census reports. See p. 494.

decade has been notable for the growth of "New England consciousness." Committees, councils, conferences, surveys have been organized and countless editorials written to stimulate a larger conception of the unity of New England, of the interdependence of its parts, and of the benefits that more favorable nation-wide publicity will bring. Research is being conducted by state and city governments, chambers of commerce, industries, and corporations as well as by academic institutions. Facts and figures are being sought for tangible benefits they may bring to the groups in whose interests the various studies are made—though not infrequently the facts and figures most eagerly gleaned are those that will seem impressive in an advertising circular or inspired news column.

Even where something more substantial than publicity is the object, however conscientious may have been the quest for data and however honestly these data may have been set forth, research as yet has disclosed only small fragments of all that should be understood. Most business men are realists. To them problems of population become less acute and finally disappear altogether as material prosperity increases—a point of view that has colored the thought of many scholars. "Constructive programs of relief," it is felt, must be based on facts capable of mathematical demonstration or its equivalent; above all else they must be practicable. So intensive has specialization become in industry and scholarship, that business man and scholar alike too often fear to allow their minds to range beyond the spheres of their immediate specialty. This is all to the good when it leads to sound conclusions regarding points of detail. It is to be deplored when, as too often, it produces blindness to the mutual relations of the multitude of details constituting the sum total of life in New England or in any one of the larger economic communities that together form New England. Where such blindness exists constructive programs are merely palliative; they allay symptoms but fail to attack the disease.

An agricultural expert is tempted to believe that most of the farmer's troubles will evaporate with the introduction of better methods of raising crops and tending live stock, with more businesslike bookkeeping, and with coöperative marketing. As long, however, as the farmer cannot command the hired labor that he requires at harvest time, as long as he is aware that his children are not receiving education of the standard he would wish for them, as long as his adult sons, following the lure of the city, leave him to face the farm work single-handed, as long as the condition of the country roads in winter and spring makes it difficult or even impossible for him to obtain the services of a physician in times of emergency, as long as he craves higher religious satisfactions than a moribund village church can give him, his feeling of disquietude and discontent will persist.

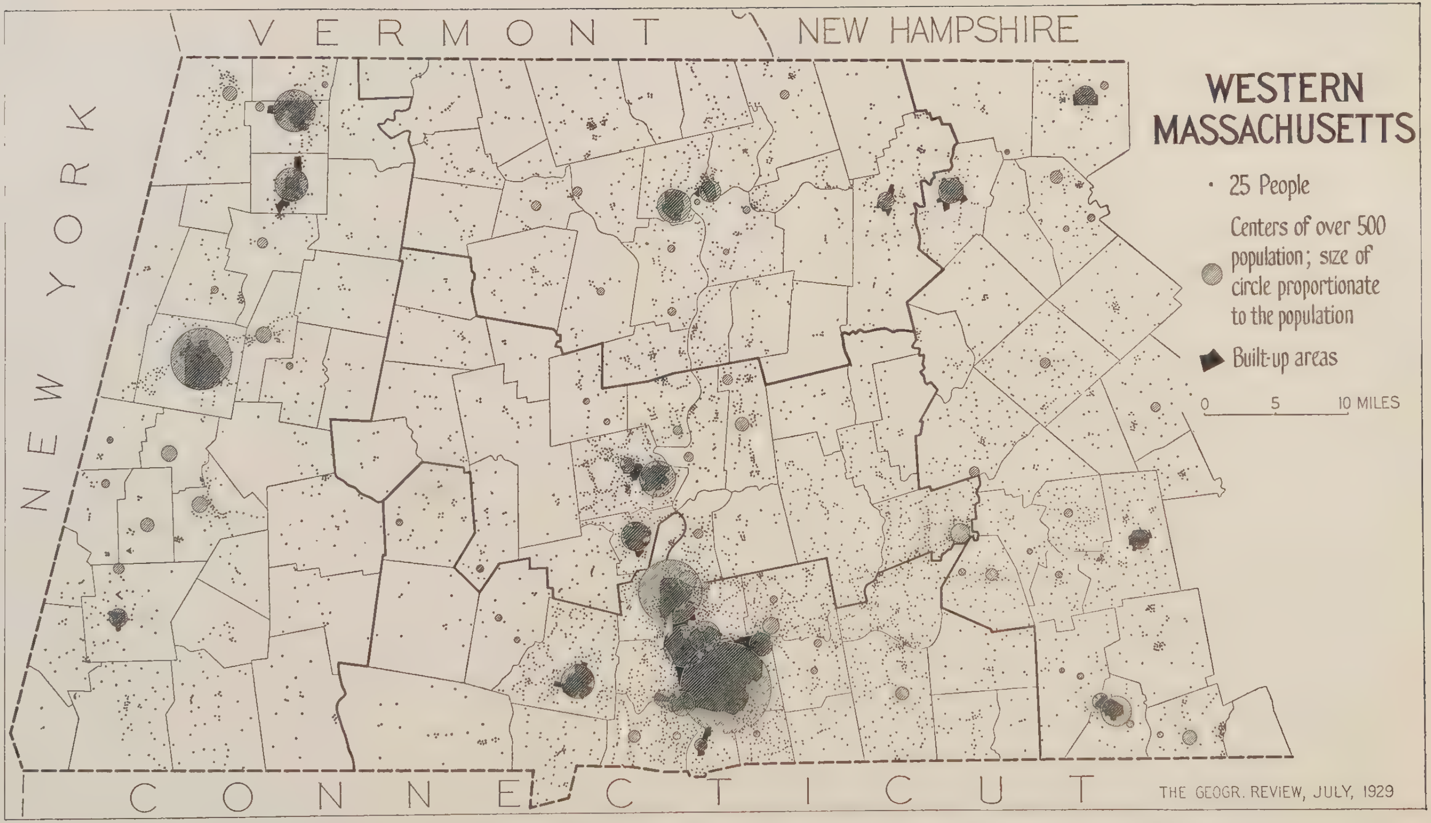
In higher wages, in education and Americanization, in model tenements and garden cities and parks the mill owner, the social reformer, and the city planner each sees solutions of the problem of urban life; but no one of these is a panacea for all ills.

When competent modern physicians undertake to cure a complicated and difficult case they first examine into all possible causes of disease or disability. Special apparatus, technical skill, and highly specialized knowledge are essential for many of their tests. The diagnosis, however, will not be complete until the interaction of the different conditions disclosed by the special tests are weighed and balanced and the condition of the organism considered as a whole. Diagnosis that is both thorough and comprehensive is needed regarding the maladjustments in the body politic of New England. The various separate factors—geographical, economic, social, historical—that combine to frustrate the efforts and hopes of large groups of people must be analyzed in detail. For such analyses the natural and social sciences offer developed techniques. Fully as important, however, is the completion of the diagnosis through the correlation of the results of each analysis. The relative importance of the various possible causes of maladjustments in the body politic must be estimated and the milieu viewed as a unit. Then only can we begin to think seriously about cures.

American Geographical Society's Study

It is an encouraging sign that a few scholars and leaders who have New England's welfare at heart see the situation in this light. Some of the papers read last December before the New England Research Council on Food Supply and Marketing give evidence of a vision transcending the limits within which the specialist is tempted to confine himself. To help pave the way for those who will seek and find solutions of New England's problems the American Geographical Society is making a coöperative study of the population in its geographical aspects. Far too large to be envisaged as a whole, New England will be broken into its parts and examined region by region. After the regional analysis has been completed, the picture will have to be put together again and studies made of those super-problems that overlie the boundaries of the regions and reach beyond the borders of New England as a whole. Particular attention throughout will be given to problems that spring from the relations of man to the natural elements of topography, rock structure, soil, and climate.

It is proposed thus to study New England region by region. First, however, we must mark off the boundaries of the regions. We must decide which regions first demand intensive examination and what distinctive problems are presented within each. We must determine



THE GEOGR. REVIEW, JULY, 1929

FIG. 2—The distribution of population in western Massachusetts. The population of each town as given in the Massachusetts census of 1925 has been distributed on the basis of a critical study of the topography and "culture" as shown on the U. S. Geological Survey sheets. Diameters of circles indicate approximate populations as follows: 0.8 millimeter = 500; 1.2 m. = 1000; 2.5 m. = 5000; 3.6 m. = 10,000; 5.6 m. = 25,000; 8 m. = 50,000; 11.6 m. = 100,000. See p. 493.

what methods in field and library are best adapted to disclose essential facts. We must survey existing maps, statistics, and reports and find out how reliable they are and how they may be supplemented in the field. We must study the methods of analyzing these data and of presenting the results of research that seem best suited to the peculiar circumstances of New England.

As a means to an end, therefore, during the initial stage of the work and coincidently with it, a reconnaissance will be made covering the whole of New England. Some results of the reconnoitering that has already been done are presented in the Appendix to this paper. Though New England-wide, this reconnaissance differs in purpose from that of the ultimate synthetic studies of New England's super-regional problems contemplated after the detailed regional studies have been completed. Essentially descriptive, bibliographic, experimental, the reconnaissance will aim to define problems rather than solve them. It will show the country through which trails of intensive study may best be followed and, in a general way, whither these trails may be expected to lead. Like a mountain outlook, it will spread below us a broad expanse of landscape before we descend into the lowlands where men live and strive.

APPENDIX

Documentary Studies and Documentary Survey

The libraries of New England contain an immense and ever increasing quantity of data waiting to be given critical expression in geographical terms. The documents from which these data may be gleaned take the form primarily of published and manuscript maps, statistics, and miscellaneous reports relating to routine work and to special investigations carried out by departments of the federal and state governments. Although in some instances they have been consulted in geographical studies—particularly by graduate students in preparing dissertations—no systematic survey of them has been undertaken with a view to their use as sources of geographical information. The Society is making such a survey an important part of its program, the purpose being not only to find material but to discover gaps that preclude the possibility of investigation along particular lines or that can only be filled through intensive studies in the field.

The accompanying maps[2] illustrate some of the preliminary results of this survey. They show the extent to which topographic and soil mapping has been carried, the areas for which certain recent statistics are available, and types of map which may be constructed on the basis of available statistics.

Topographic Maps

The most important topographic maps of New England are, of course, the sheets of the U. S. Geological Survey on a scale of 1:62,500, or approximately one inch to a mile (Fig. 3), supplemented by the coast charts and the U. S. Soil Survey sheets. For cultural features alone, some of the later Soil Survey maps (Fig. 3, inset) are more nearly up-to-date than the U. S. G. S. sheets. Although the Soil Survey in New England has used the topographic sheets as its base, houses, roads, reservoirs, and the built-up parts of cities and villages have been corrected.[3] But, aside from the coast charts, the soil maps, and a very few exceptional maps of small areas (such, for example, as the Appalachian Mountain Club's maps of the White Mountains), the Geological Survey's sheets are the ultimate documentary authority for the topography and "culture" of the larger part of contemporary New England.

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[2] Compiled by Miss Lois Olson of the staff of the American Geographical Society.

The Geological Survey's topographic sheets, however, are not all of the same utility. The earliest surveys in New England were made in the eighties and nineties of the last century, at a time when the Survey's standard was not as high as it has since become. While the earlier sheets have in most cases been issued with minor corrections, they have not been subjected to thoroughgoing revision. Consequently the maps based on the earlier surveys are not only out of date as regards the works of man but are often inaccurate in their representation of water and relief. Some idea of the relative value of the U. S. G. S. sheets on a scale of 1:62,500 may be gained from Figure 3, which shows the dates by decades of the original surveys upon which the different sheets are based. This key map also distinguishes the sheets upon which house dots are indicated in rural areas and upon which woodland[4] is shown. In the earlier editions of many of the sheets for parts of southern New England no town boundaries were represented, but these have been added on later editions.

As will be seen from Figure 3, there are large tracts in the three northern New England states that have not as yet been mapped. These tracts are confined for the most part to forested and other sparsely populated country. For such areas the best one can do is to turn to the county and town maps published commercially during the last half of the nineteenth century.[5] Drawn on scales of one inch to the mile (1:63,360) or slightly larger, these maps show mountains and hills sketchily by hachures. Their primary value, however, lies in their representation of "culture"—buildings, roads, farmhouses, sawmills, gristmills, schools, churches, etc. The names of the mills, schools, churches, and of the owners of property are also indicated, and similar data are supplied for villages and cities on inset plans and special maps of larger scale.

Besides these published maps, there are preserved in the collections of the state historical societies as well as in libraries and archives many manuscript town maps of early date. By enactment of the General Court the Massachusetts towns were required in 1794 and again in 1830 to furnish maps of their territory for use in the compilation of maps of the whole state. There is a file of these town maps, nearly complete, in the State Archives at Boston. Some of the surveys were carried out by professional surveyors and were both accurate and detailed, the resulting maps showing not only the town boundaries, roads, and principal bodies of water but also the location of forests and buildings. For other towns, however, the work was done by inexperienced men, and the results were of inferior quality.

Index Map to Census Data

In drawing maps on the basis of available statistics showing for all New England the distribution of the various facts of population, agriculture, industry, social life, etc., technical problems arise. Some of these are peculiar to New England and spring from the character of the existing statistics and the manner in which they are presented.

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[3] W. J. Latimer: General Methods Used in Mapping Soils in Massachusetts, and Some of the Problems, *Rept. Fifth Annual Meeting of the American Soil Survey Association, Held at Chicago, Ill. November 20 and 21, 1924*, Bull. 6, Vol. 1, Ames, Ia., 1925, pp. 33–37.

[4] A map of Connecticut (1:125,000) published in 1893 by the U. S. G. S. in coöperation with the State of Connecticut shows wooded areas. The U. S. G. S. has also issued recently ten advance sheets (1:24,000) based on aerial photographs taken in 1928 and covering part of the Connecticut Valley in Connecticut. These show roads, wood lots, and fences but not buildings.

[5] Reference to some but not all of these maps will be found in P. L. Phillips: A List of Maps of America, 2 vols., Washington, 1901; *idem*: A List of Geographical Atlases in the Library of Congress, 4 vols., Washington, 1909–1920.

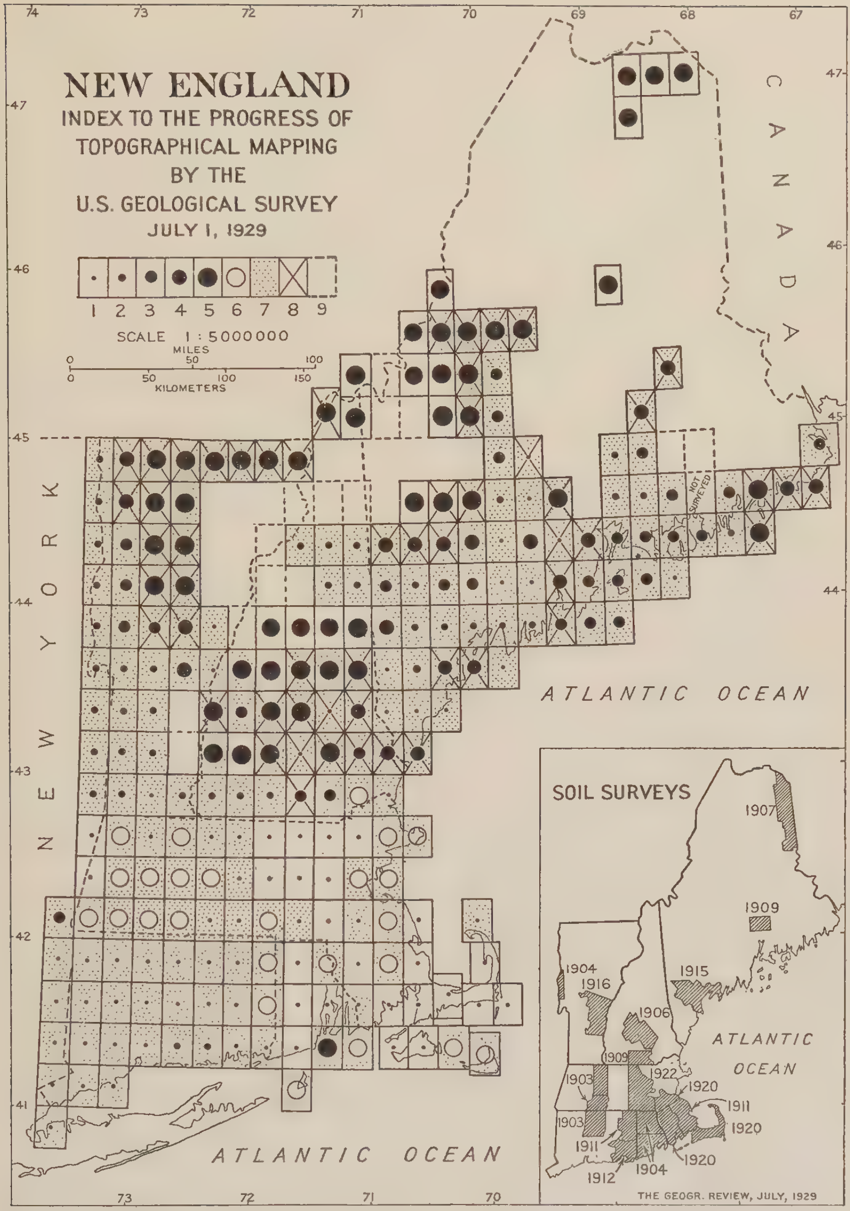

FIG. 3—Maps showing progress in New England of topographical mapping by the U. S. Geological Survey and of soil surveys by the U. S. Department of Agriculture, Bureau of Soils. Explanation: 1–8, topographical sheets (1:62,500) published or advance sheets (1:48,000) issued. 1, surveyed before 1890; 2, surveyed 1890–1899; 3, surveyed 1900–1909; 4, surveyed 1910–1919; 5, surveyed since 1919; 6, surveyed before 1890, revised sheets published 1910–1919; 7, houses shown in rural areas; 8, woodland shown (see also footnote 4, p. 488); 9, surveys completed or proposed, but sheets not yet issued. Scale of inset approximately 1 : 13,000,000.

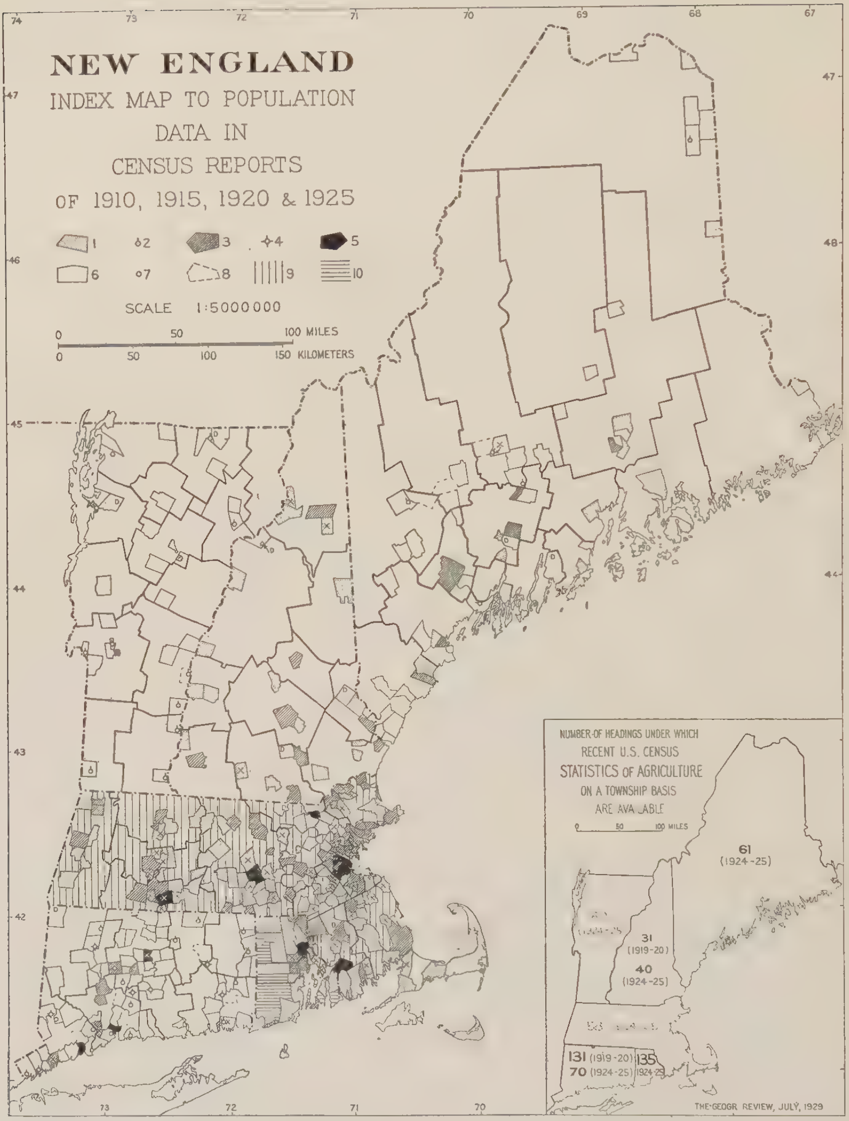

FIG. 4—Index maps to recent population and agricultural statistics by towns in New England.

EXPLANATION OF FIGURE 4

Figure 4 with the inset differentiates the areas in New England for which there have been tabulated by *cities, towns, and lesser administrative areas* federal and state census statistics for the last twenty years.

Blank areas (except those outlined by Symbols 6 and 8) are areas included in towns having less than 2500 inhabitants in 1910 and 1920. For such towns no federal or state census statistics are available other than the figures for the total population and certain figures for agriculture (see explanation of inset map, below).

Symbols 1, 3, 5, and 6 represent towns and cities, and *Symbols 2, 4, and 7* represent incorporated places not coextensive with the townships within which they lie, for which federal census data on the composition and characteristics of the population are given either in one or in both censuses of 1910 and 1920. *Symbols 9 and 10* represent areas for which state, but not federal, census statistics are available for composition and characteristics of the population on a township basis.

Symbols 1 and 2. All these places had between 2500 and 10,000 population in both 1910 and 1920, except those marked X, which had less than 2500 in 1910 but between 2500 and 10,000 in 1920. Statistical data on the "composition and characteristics" of the population are furnished in the federal census reports for 1920 for all these places, and in the reports for 1910 as well for all those not marked X. These data are presented under headings of Color or Race, Nativity, and Sex; Illiteracy; School Age and Attendance.

Symbols 3 and 4. All these places had in 1910 and 1920 a population between 10,000 and 100,000, except those marked X, which had a population of less than 10,000 in 1910. For all these places all the data on the composition and characteristics of the population mentioned above are presented in the federal census reports for both 1910 and 1920. For the places not marked X both reports, and for the places so marked the report of 1920 only, present, in addition, more detailed statistics. For example, the foreign-born population is analyzed according to the country of origin, the population is classified into additional age groups, and a variety of other totals and percentages are furnished that are not provided for places of smaller size. There are also certain material differences between the categories of the censuses of 1910 and 1920.

Symbol 5. Cities having in 1910 and 1920 a population of over 100,000, unless marked X, in which case the population was less than 100,000 in 1910. More complete statistics are furnished for cities of more than 100,000 inhabitants than for those of less than 100,000.

Symbols 6 and 7. For these places data on the composition and the characteristics of the population are given in the report of 1910 *but not in 1920.* They all had a population of over 2500 in 1910, but those marked D had declined to less than 2500 by 1920.

Symbol 8. Towns having more than 2500 population in 1920 but less than 2500 in 1910; for these places no data whatever on the composition and characteristics of the population are given in either census report.

Symbol 9. Areas for which the Massachusetts state census of 1915, but not the federal census reports, gives by towns data on the composition and characteristics of the population. The Massachusetts state census of 1925 tabulates merely the total population by towns.

Symbol 10. Areas for which the unpublished Rhode Island census of 1925 and the published Rhode Island census of 1915, but not the federal census reports, give by towns data on the composition and characteristics of the population. Through the courtesy of Mr. E. L. Byers, Commissioner of Labor, the American Geographical Society has obtained a photostatic copy of the Rhode Island census of 1925.

Census statistics of manufactures. Federal censuses of manufactures were taken in connection with the Thirteenth and Fourteenth Censuses of the United States in 1909 and 1919, and also in 1914, 1921, 1923, 1925, and 1927. In the reports for 1909, 1914, 1919, and 1925 for all cities and for certain towns of over 10,000 inhabitants statistics are presented relating to the number of establishments, persons employed, primary horse power, expenses, capital, value of product, value added by manufacture. In the reports for 1909, 1914, and 1919 more complete details are given for places of over 50,000 inhabitants and in the report for 1925 for places of over 100,000. The reports for 1921 and 1923 present statistics by cities for cities of over 100,000 only.

The towns and cities for which these data are given in the reports of 1909, 1914, 1919, and 1925 are those indicated by Symbols 3, 4, and 5 on Figure 2, with, however, the following exceptions: *Maine:* Bath, 1919 and 1925 only; Sanford, 1914; *Massachusetts:* Amesbury, Dedham, Milford, Natick, West Springfield, and Winchester, 1914 and subsequent years only; North Attleborough, 1914 only; Belmont, Braintree, Danvers, Easthampton, Norwood, and Saugus, 1919 and 1925 only; Northbridge, 1919 only; Watertown, not given for 1925; *Connecticut:* Bristol and Norwalk, 1914 and subsequent years only; Derby, 1919 and 1925 only; *Rhode Island:* Lincoln, 1914 only; Bristol and West Warwick, 1919 and 1925 only; Cumberland and Warwick, not given for 1925.

Inset map. This indicates the number of headings under which recent agricultural census statistics have been tabulated by towns, together with the dates to which these statistics apply. The figures for Massachusetts and Vermont are given in broken lines because the statistics were not available in published form when this paper went to press. Through the courtesy of Mr. C. D. Stevens of the New England Crop Reporting Service the American Geographical Society has obtained.

The statistical output of the states is far from uniform as regards either subject matter or methods of tabulation, and even the federal census itself has not always been entirely consistent in its treatment of the different New England states. Definite bounds are thus set beyond which the cartographer cannot go. Not only is the number of distributions for which figures are to be had strictly limited but the optimum cartographic precision that may be attained depends on the size and distribution of the unit areas to which each figure applies. Obviously a better map can be drawn on the basis of statistics by cities and towns (in the New England sense of "township") than by counties, a better map if the basic figures are given for all towns and cities than if they are given for only a few.

Figure 4 may serve as a key to the U. S. decennial censuses of 1910 and 1920, the U. S. Census of Agriculture of 1925, the U. S. censuses of manufactures of 1909, 1914, 1919, 1921, 1923, and 1925, and to the Rhode Island and Massachusetts state censuses of 1915 and 1925. County boundaries are shown, together with the relative number of statistical data provided in these reports for the various towns and cities of New England. For the towns and cities represented by the darker symbols more statistical material is to be had than for the ones shown by lighter symbols. For the areas left white the only existing census figures for the last twenty years are the figures for the total population of each town.

This map covers only census statistics. There is, of course, other statistical material available by townships. Vital statistics published by state health departments cover births, marriages, deaths and causes of death; the published reports of state assessors or tax commissioners, beside giving property valuations and tax rates, usually indicate the number of taxable live stock; in the reports of the departments of education there are many figures regarding school attendance, school equipment, and finances. The Market Data Handbook of New England, recently published by the U. S. Department of Commerce as Part III of The Commercial Survey of New England, tabulates by towns statistics covering wealth factors (bank deposits and number of income tax returns), standard of living factors (home tenure, residence telephones, homes using electricity and gas, average new automobile sales, circulation of magazines), and trade factors (wholesale and retail trade outlets). The number of dollars in domestic money orders issued in 1927 is presented for every post office in New England and the amount in money orders paid for every first and second class post office.

As regards areas it may be noted that figures for the Vermont towns are given in acres in Walton's Vermont Register, published annually by The Tuttle Co., Rutland, Vt. For New Hampshire a tabulation was compiled in 1924 by the State Forestry Department and is available in multigraphed form. For Massachusetts the areas of towns are given on pages 82–86 of the Decennial Census of the Commonwealth,

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a photostatic copy of the Massachusetts statistics as tabulated by the Bureau of the Census for the Massachusetts Department of Agriculture. The pertinent statistics for the other states, together with maps drawn from them, will be found in the following publications:

I. G. Davis and C. I. Hendrickson: A Description of Connecticut Agriculture, *Storrs Agric. Exper. Sta. Bull. 127*, Storrs, Conn., March, 1925 (for 1919–1920 figures).

I. G. Davis and J. R. Jacoby: Five Year Trends in Connecticut Agriculture, *Storrs Agric. Exper. Sta. Bull. 146*, Storrs, Conn., November, 1927 (for 1924–1925 figures).

New Hampshire Department of Agriculture, Division of Statistics: Agricultural Census Report of the State of New Hampshire by Towns, July, 1922 (for 1919–1920; for 1924–1925 see work of same title dated April, 1926).

R. B. Corbett: Rhode Island Agriculture, a Statistical Description, *Rhode Island State College Agric. Exper. Sta. Bull. 206*, Kingston, R. I., August, 1926 (for 1924–1925 figures).

C. H. Merchant: Maine Agriculture, a Statistical Presentation, *Maine Agric. Exper. Sta. Bull. 338*, Orono, Me., March, 1927 (for 1924–1925 figures).

1915, and for Rhode Island on pages 59–60 of the Rhode Island Census Report of 1895. For Connecticut a table showing the acreage of each town from the Report of the Connecticut Bureau of Labor Statistics for 1902 is reprinted in Bulletin 127 of the Storrs Agricultural Experiment Station, March, 1925, pp. 124–132. For Maine no corresponding published data are available.

Figure 4 illustrates two very important circumstances that are true (with differences in details) not only of the recent census statistics for New England but of the earlier census statistics as well.

In the first place, it shows that one cannot on the basis of published census figures make maps on which there will be apparent for *every* town in New England any of the interesting and significant totals or ratios which the census reports tabulate for every county and for the larger towns and cities in regard to foreign-born and native population, age groups, naturalization, sex, school attendance, families, dwellings, farms, crops, farm mortgages, manufacturing establishments, etc.

In the second place, Figure 4 and its explanation make it clear that there are, nevertheless, many towns and cities for which the important and significant facts of the type specified in the preceding paragraph *are* given in the census reports and that these places comprise a considerable area and a large proportion of the population, particularly in southern New England.

This leads to a dilemma in the mapping of data from the census statistics. If town and city statistics alone are used there will be large blank spaces on each map; if county statistics alone, the texture of the resulting maps will be too coarse. The New England county is far too large an area in relation to the various natural, economic, or social regions into which New England might be divided to serve as an adequate statistical unit for any but the most generalized type of map. A compromise, however, may be effected by constructing "hybrid" maps based on a combined use of statistical data presented by counties on the one hand and by towns and cities on the other.

"Hybridization," of course, could be avoided by tabulating and plotting from the original census schedules the pertinent data for all towns for which such data are not given in the published reports. For agriculture tabulations have recently been made by towns for all the New England states, as may be seen in the inset map in Figure 4. Such tabulations involve considerable expense; furthermore, owing to the dispersal and disappearance of many of the original census schedules, they probably could not be carried out on a comprehensive scale for all New England except in the case of the 1920 census.

MAP OF THE DISTRIBUTION OF POPULATION IN WESTERN MASSACHUSETTS

The distribution of population in western Massachusetts is illustrated in Figure 2. Each dot indicates 25 people in rural areas; the built-up parts of villages and cities are shown in black, and the number of inhabitants of centers of over 500 is indicated by circles proportionate in area to the population of each place. The map represents an attempt to plot the Massachusetts state census figures of 1925 for the total population of each town in such a way that a picture of the actual distribution of population within each town is approximated. This involved a critical examination of the topographic sheets of the U. S. Geological Survey, the Soil Survey maps, and certain other maps. Estimates of the population of certain villages given in the atlases of Rand McNally and Cram also served as a guide. The map as it stands is based exclusively on the study of documents and is reproduced merely to illustrate the method. Before a definitive map of this sort for all New England (on the basis of figures to be determined by the Fifteenth U. S. Census) could be published it would be necessary to submit a preliminary draft to such local authorities as farm agents, school superintendents, or town clerks for criticism of the representation of the towns with which they are acquainted.[6]

MAP SHOWING THE PERCENTAGE OF NATIVE WHITES OF NATIVE PARENTS IN THE TOTAL POPULATION

The great wave of foreign population that flooded New England before the recent restriction of immigration has created social and economic problems of the first magnitude. Where are these problems most likely to become accentuated? Figure 1 may provide a background for studies of this question.

The U. S. census reports for 1910 and 1920 give for counties, cities, and certain towns the number of native whites of native parentage, native whites of foreign or mixed parentage, and foreign-born whites. Figure 1 shows by different symbols the percentages of native whites of native parentage in the total population, *the lighter the tint the higher being the per cent indicated.* This map represents what is probably the highest degree of regional precision attainable in mapping this distribution on the basis of recent published U. S. census statistics. The figures do not permit the construction of a more detailed map showing this particular distribution. The map is of the "hybrid" type discussed above.

The appropriate percentages for 1920 are plotted separately for every city, for every town that had a population of over 2500 in 1910 or 1920, and for the remaining settled area of every county, unsettled areas (including minor civil divisions of less than 50 inhabitants) being left blank. It is thus possible from the map to compare the cities and larger towns with one another and with the less thickly settled parts of each county, but it is not possible to compare individual small towns.

Three different types of area are shown:

1. Cities, towns, and other incorporated places for which the 1920 census gives the number of native whites of native parentage (Fig. 4, Symbols 1–5).
2. Towns for which the 1910 census, but not that of 1920, gives the number of native whites of native parentage (Fig. 4, Symbol 6).
3. Settled areas in each county not included in areas of either Type 1 or 2. These areas, in turn, are of two types:
    - 3a. Those which lie in counties that *do not* include areas of Type 2.
    - 3b. Those which lie in counties that include areas of Type 2.

For all areas of Types 1 and 3a the percentages were calculated directly from the 1920 census figures. For all areas of Types 2 and 3b they were estimated on the basis of a comparison of the 1910 and 1920 census reports.

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[6] See C. E. Batschelet: A Picture of the Distribution of Population in Pennsylvania, *Geogr. Rev.*, Vol. 17, 1927, pp. 429–433.

AN ISOPLETH MAP OF LAND UNDER CROPS IN INDIA

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THE government services in India have long gathered and published valuable data on the details of land utilization in this great low-latitude country, data comparable in accuracy and scope with those gathered in the more advanced countries of the Western World. The recently published "Report of the Royal Commission on Agriculture in India"[1] admirably summarizes this work as well as the wide variety of fundamental researches carried on by the agricultural services. In addition, this Report includes numerous recommendations for further work, including soil surveys. As a geographer reads these recommendations, however, he wonders at the lack of recognition of the need of publication of a variety of maps at present unavailable, maps which portray the areal spread of the agricultural facts now set forth only in statistical tables. One such fundamental map much needed is that showing the distribution of land under crops. To supply this need in a preliminary way the accompanying map of percentage of land in crops has been constructed, based primarily on statistical data published for some three hundred odd small political divisions covering about three-quarters of the area of the country, excluding Baluchistan.

In order to construct the map here presented, the appropriate ratio was calculated for each statistical division and plotted in the center of the division. Descriptions in the "Imperial Gazetteer of India" of relief, soil, and land utilization, together with information on detailed topographic maps published by the Survey of India, were then used in numerous places as a basis for inferences as to proportion of area under crops, which inferences enabled isopleths to be drawn with greater probable accuracy than would have been possible had the statistics alone been employed. The map undoubtedly is far from precise in many places, but it comes much nearer representing reality than a map constructed solely from the plotted figures. The probable degree of accuracy of the map is lower in the eastern part of Central India Agency, in Orissa, and in the eastern part of the Central Provinces, than elsewhere, since agricultural statistics are not available for many native states in these areas.

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[1] Cmd. 3132, June, 1928. The total cost of the Commission is estimated at about £102,955. See the discussion of the Report in *Nature*, Vol. 122, 1928, pp. 134–135 and 175–177; Vol. 123, 1929, pp. 233–235.

This map, approximate though it be, puts the published data in a form suitable for geographic use. It shows, as statistical tables cannot, the extent and location of areas where a large part of the land is under crops (80 per cent is about the maximum) and the areas where but a small part is under crops. It brings sharply to the investigator's attention the question as to why the percentage of crop land is high in certain regions and low in others, as well as the question as to what are the possibilities, in various sections of the country, of increasing the cropped area.

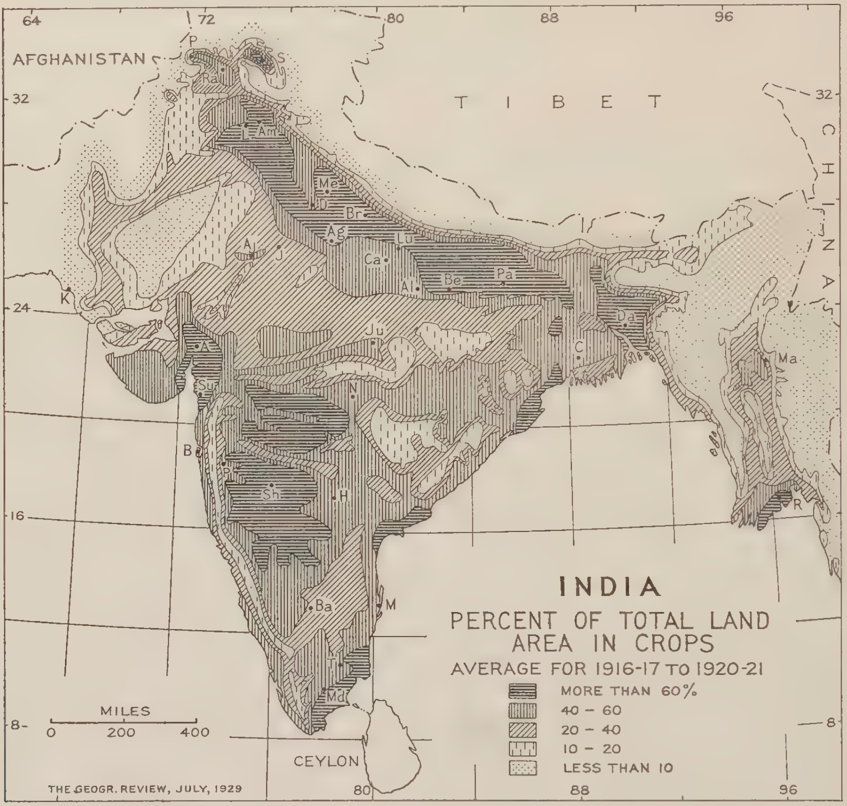

FIG. 1—Isopleth map showing the percentage of total land area that is under crops in India. Cities of more than 100,000 population are indicated by dots and initial letters. Scale 1:32,000,000.

Such a map could be made by the agricultural services in India, based not only on the statistical data and the literature but also on the wealth of detailed field knowledge available, which would possess a high degree of accuracy. As a basis for present studies, and as a record some years hence, such a contribution to the knowledge of this land, where nearly three-quarters of the three hundred and twenty millions of population are directly dependent on agriculture, is greatly to be desired.

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of March and April. At the regular monthly meeting of the American Geographical Society held on March 26, 1929, at the Engineering Societies' Building, 29 West 39th Street, President Finley presiding, Mr. Lowell Thomas gave a lecture entitled "Through Romantic India and into Forbidden Afghanistan." In 1923, after repeated attempts to gain admittance, Mr. Thomas entered Afghanistan by way of the Khyber Pass. The description of his experiences in the country was illustrated by striking motion pictures.

At the regular monthly meeting of the Society on April 23, 1929, held at the Engineering Societies' Building, 29 West 39th Street, Honorary President Greenough in the chair, Captain Sir Hubert Wilkins addressed the Society. He spoke on "Antarctic Exploration by Airplane," prefacing the account of his Antarctic experiences by a summary of the Arctic work of 1926, 1927, and 1928. The address was illustrated by motion pictures taken during the preliminary flight about Deception Island and on the great flight to latitude 71° 20′ S. Pictures were also shown of the whaling activities at Deception Island. The complete report of Captain Wilkins' season's work in the Antarctic is printed on pages 353–376 of this *Review*.

Elections to Fellowship. At the March meeting of the Society, President Finley presiding, and the April meeting, Honorary President Greenough presiding, there were presented with the approval of the Council the names of 42 candidates who were duly elected as Fellows of the Society.

The Map of Antarctica. The Society's large four-sheet map of the Antarctic prepared as the field map of Commander Byrd's and Captain Wilkins' expeditions (see *Geogr. Rev.*, Vol. 19, 1929, p. 148) is being revised and reissued as fast as new information becomes available. The American Quadrant, which includes Graham Land, has been redrawn to include Captain Wilkins' discoveries (see Pl. IV, facing p. 374) and will be issued without cost to all holders of the original map who will send their names and addresses to the Society. The quadrant will correspond in lettering, color, and size to the original one. A similar reissue of the Pacific Quadrant of the map of the Antarctic will be made after Commander Byrd's longer flights of the coming season.

Log Books of the U. S. Brig "Rescue." Through the kindness and generosity of Miss Cora Griffin and Mrs. Herbert R. Woods, daughters of the late Samuel Palmer Griffin, there have been given to the Society the two log books of the U. S. Brig *Rescue*, which cover the period (1850–1851) in which the ship was in the service of an expedition commanded by Captain Griffin which set out to find Sir John Franklin. The log books are of special interest as part of the source material relating to the history of that long search in which so many historic ships and explorers participated.

Captain Sir Hubert Wilkins' Original Records. After his return from the Alaska-Spitsbergen flight of 1928 Captain Sir Hubert Wilkins gave to the Society all of his original records, including his navigational charts, log books, and notebooks. Upon his return from the Antarctic in March, 1929, Captain Wilkins again gave to the Society all of his original maps and notebooks as well as a collection of his most important photographs. The value to science of such original materials is almost incalculable, and interest in them becomes especially keen when we recall that the period is fast closing in which there remains any important extent of still undiscovered coast.

GEOGRAPHICAL RECORD

NORTH AMERICA

The Mammoth Cave Region. In a booklet, liberally illustrated with sketches, block diagrams, and photographs, Dr. A. K. Lobeck gives a popular description of "The Geology and Physiography of the Mammoth Cave National Park" (*Kentucky Geol. Survey*, Ser. 6, Pamphlet 21, Frankfort, 1928). He utilizes the method adopted by him in the "Guide to the Allegany State Park" (see the *Geogr. Rev.*, Vol. 18, 1928, p. 702) and links up the local physiography with the general physiographic principles involved in the study of karst topography. A more detailed and technical account of the geology and geologic resources of the area is contained in "The Geology of Edmonson County," by J. M. Weller (*Kentucky Geol. Survey*, Ser. 6, Vol. 28, Frankfort, 1927). The comparatively recent publication of a number of U. S. Geological Survey topographic maps of the area has encouraged the study of the local sink hole topography. It has been estimated that the Mammoth Cave quadrangle alone shows 2833 sink holes and that the surrounding area contains no less than 60,000 to 70,000 (W. R. Jillson: The Topography of Kentucky, *Kentucky Geol. Survey*, Ser. 6, Vol. 30, Frankfort, 1927). Through the region flows the Green River marking in a general way regions dissimilar both physiographically and culturally. To the south "lie all the caves of the region and here, too, sink holes and valley sinks abound. Flat-topped plateau remnants make up a large fraction of the area although over one-half of the original plateau has given way to sinks and depressions. It is under these flat-topped mesa-like pieces of country that the largest caves are found. The northern half is a rugged hilly country with few or no sinks except along a belt near Green River. . . . Culturally, there is also a noticeable difference in the two areas. This is due largely to the fact that the northern part is distinctly isolated owing to the presence of the Green River Gorge. . . . Poor roads and a distinct dependence upon resources characterize the northern areas." Quite the opposite are conditions to the south in the Pennyroyal plateau, with its many roads and railroads, its frequent towns and villages, its extensive farms and broad cultivated tracts. For a detailed description see "Geography of the Pennyroyal," by C. O. Sauer (*Kentucky Geol. Survey*, Ser. 6, Vol. 25, Frankfort, 1927).

The Mountains of Arizona and Sonora. Leo Waibel has made an interesting comparison (Die Inselberglandschaft von Arizona und Sonora, *Zeitschr. Gesell. für Erdkunde zu Berlin*, Sonderband zur Hundertjahrfeier der Gesell., herausg. von Albrecht Haushofer, 1928, pp. 68–91) between the residual mountains that rise from the extensive rock plains of arid Africa and the somewhat similar features of Arizona and Sonora, with both of which regions he has had field acquaintance. He emphasizes the large area of the worn-down rock plains and the small size of the residual mountains in Africa in contrast to the opposite relations in arid America, where the rock plains, or "pediments," are as a rule of restricted development between larger areas of moderately dissected mountains on one side and of heavily aggraded depressions on the other; and he ascribes the different areas of the rock plains in the two regions to the long quiescence of the one and the relatively recent deformation, largely by block faulting, of the other. He describes in some detail the peculiar drainage features of our arid Southwest and gives well deserved praise to Kirk Bryan's work on the "Papago country" of Arizona where the "Inselberglandschaft" has its best development in the United States. But, curiously enough, Waibel rejects the idea that these island mountains are to be explained by a climatic modification of the normal cycle of erosion, perhaps because he does not recognize that the English word, erosion, includes two processes, river corrasion and areal degradation, to which Germans usually give the separate names of *Erosion* and *Abtragung*. Nevertheless he quotes with apparent acceptance Bryan's examples of the progressive stages of arid erosion (arid degradation being implicitly included therewith); and his own descriptions show clearly enough that the above-noted physiographic contrasts between arid America and arid Africa are due to nothing more than the earlier and the later stages of the cycle of arid erosion through which they have progressed. Furthermore, Waibel's essay makes it clear that the modifications by which normal erosion, such as characterizes moist climates, is transformed into arid erosion are chiefly associated with the great activity of the rills and rivulets of arid regions at times of wet weather, when in consequence of scanty plant cover they gain a transporting power vastly greater than rills and rivulets possess in plant-covered regions.

W. M. Davis

Earthquake History of the United States Exclusive of the Pacific Region. In 1925 the Coast and Geodetic Survey was authorized to carry on seismological investigations in the United States (see *U. S. Coast and Geodetic Survey Special Publ. No. 132*, 1927). In that year occurred an earthquake in the lower St. Lawrence Valley notable for its intensity and the extent of territory over which it was felt. Little damage was done, for the epicenter, on a fault line crossing the St. Lawrence 90 miles below Quebec, fell in an area of scant population, but it was sufficient to indicate the reality of the hazard and to attract general attention to the earthquake problem in the United States and Canada (E. A. Hodgson: The St. Lawrence Earthquake, February 28, 1925, *Trans. Royal Soc. of Canada*, Ser. 3, Vol. 21, Part II, Section IV, 1927, pp. 145–152).

Commander N. H. Heck divides the United States into five seismic regions: the northeastern, including New England and New York, which region shares in the principal earthquake activity of Canada and has much of its own; the eastern, including the Appalachian activity; the middle western, the area between the preceding regions and the Rocky Mountains; the western mountain region; and the Pacific coast region. The history of the last-named region is covered by two catalogues of earthquakes, from 1769 to 1897 and from 1897 to 1906 respectively, published as *Smithsonian Miscellaneous Collections*, and a third is now in preparation. In "Earthquake History of the United States Exclusive of the Pacific Region" (*U. S. Coast and Geodetic Survey Special Publ. No. 149*, 1928) Commander Heck presents a record of the seismic activity of the first four regions. Earthquakes of intensity 5 and over on the Rossi-Forrel scale are listed chronologically by regions; brief comment is made on the minor quakes, more considerable description of the major occurrences including those of 1663 and 1925 in the St. Lawrence Valley, that of Charleston in 1886, and the exceptionally interesting New Madrid earthquakes of 1811 and 1812.

Tropical Cyclones off the West Coast of Mexico. The increased volume of traffic since the opening of the Panama Canal has focused the attention of seamen and meteorologists upon the ocean bordering the west coast of Mexico, a region of dangerous summer and autumn cyclones. Though Mexican fishermen of the west coast have long been aware of the recurrence of the "lash of St. Francis," and though Sir William Dampier and later navigators have described these storms, their cyclonic character has not been recognized generally. In 1856 Redfield plotted the paths of thirteen cyclonic storms that occurred between 1842 and 1855, and the "Segelhandbuch für den Stillen Ozean" of the Deutsche Seewarte lists forty-five occurring between 1832 and 1892. Together they give an average of little more than one storm per year. These two sources have been the basis for studies of tropical cyclones of the eastern North Pacific up to the present time.

Coöperation between seamen and the United States Weather Bureau has enabled Willis Edwin Hurd in "Tropical Cyclones of the Eastern North Pacific" (*Monthly Weather Rev.*, Vol. 57, 1929, pp. 43–49) to identify eighty-five tropical cyclones that originated off the west coast of Mexico between 1910 and 1928. September is the month of greatest cyclonic activity, and a maximum of thirteen storms occurred in 1925. In the "Atlas Climatológico de la República Mexicana: Período de 1921 a 1925" Pablo Vázquez Schiaffino has traced the trajectories of thirty-eight cyclones occurring between 1921 and 1925. Of these, twenty-eight were also identified by Hurd, but ten were not otherwise recorded. This increases to ninety-five the number of storms noted between 1910 and 1928—making an average of five annually.

Four types of cyclones are recognizable: (1) those paralleling the coast of Mexico from Tehuantepec northward; (2) those of more southerly origin moving northward and striking upon the Mexican coast; (3) the storms originating near the Revillagigedo Islands and moving to the northwest or southwest; and (4) the less frequent storms originating between longitudes 125° and 155° W. Since 1832 but seven storms belonging to this last group have been definitely identified. Beyond longitude 155° W., to the southwest of Hawaii, is a region covered by few observations. Though evidence indicates that some northward-moving storms originate here, the fact is not established. Further observations will be needed to bridge the hiatus between the area of Mexican cyclones and that of the Oriental typhoons.

In the "Atlas Climatológico de la República Mexicana" Schiaffino has extended the paths of several Pacific cyclones across the plateau of Mexico to the Gulf. An extreme case is plotted on the "Carta del Tiempo" of the Servicio Meteorológico Mexicano for September 23, 1928. A cyclone originating in the Caribbean Sea is traced across the plateau of Mexico to the Pacific Ocean near Acapulco. Here it recurves, crosses the northern plateau, and emerges upon the Gulf coast near Matamoros. The period between September 16, when the storm first entered the mainland of Mexico, and September 23, when it disappeared in the Gulf, was accompanied by storms of unusual severity throughout Mexico and especially between Tampico and Monterrey, where desert was converted into swamp and railroad tracks were washed away. Though occasional cyclones known to have originated in the Pacific have crossed the Isthmus of Tehuantepec and entered into the circulation of the Gulf of Mexico, Hurd questions the ability of such storms to rise above the escarpment of the western sierras. He attributes the occurrence of storms on both coasts to the simultaneous development of barometric depressions of independent origin.

A Russian Colony in Mexico. During twenty-five years of forced exile in Kars and another quarter of a century of voluntary exile in Lower California, a colony of peasants from the plains of southern Russia has maintained its identity. What will be its ultimate destiny? This question is raised by Oscar Schmieder in his study of "The Russian Colony of the Guadalupe Valley" (*Univ. of California Publs. in Geogr.*, Vol. 2, 1928, No. 14, pp. 409–434). Originally the Molokanye, "sectarians closely resembling the Scotch Presbyterians," formed a progressive element within Russia, which was unable to accept the dogma of the Orthodox Greek Church. Cultural isolation in the Armenian highlands fostered conservatism among them, and in the Guadalupe Valley the Russian *mir* system has been transplanted to Mexican soil. Land is owned in common, and shares of both good and poor land are distributed among the families in proportion to the size of each. Frequently a man's fields are not contiguous. This discourages the establishment of isolated farms and promotes community life.

Following the example of other Russian dissenters, the Doukhobors, for instance, many emigrated from Russia first to Canada. But the Molokanye found the climate was too suggestive of their exile in Kars. In southern California, where a colony of Russian Mennonites had settled, the climate was satisfactory but the land too expensive. The Guadalupe Valley, fifty miles south of the Mexican border, offered abundant cheap land, a warm Mediterranean climate, fertile alluvial soil, and an adequate supply of ground water. Wheat, the chief crop, is raised in the winter without irrigation. During the dry summer season the fields are converted into pasture. When the Molokanye arrived, the best wheat land in the region produced sixty bushels per acre. Reckless cultivation has reduced it to fifteen. This decreasing yield is balanced by an increase in acreage under cultivation. American agricultural implements have added to the amount of land that one man can cultivate, and an almost unlimited quantity of land can be rented from the Indians. Frequently fields are so far removed from the village that, during periods of cultivation or harvest, it is necessary for the men to camp for weeks at a time near their work.

When the Russians came to the Guadalupe Valley they completely displaced their predecessors, ranch owners and Indians. Their few neighbors are chiefly Indians. A hundred miles to the south, the uninhabited San Borja Desert begins. The country between has a rainfall too scant (5–10 inches) and too irregularly distributed to permit farming except in places where the ground water supply is particularly favorable. Efforts to establish missions have resulted in the extinction of the Indians and the abandoning of the missions (Carl Sauer and Peveril Meigs: Site and Culture at San Fernando de Velicatá, *Univ. of California Publs. in Geogr.*, Vol. 2, 1927, No. 9, pp. 271–302). Distance from the capital has increased isolation, and until recently the Russians have been relatively free from government intervention. On the other hand, the small size of the community (about a hundred families) makes it difficult to maintain its independence. The United States to the north attracts the youth of the colony, and the Mexican government now demands that children under twelve attend a Spanish school. Older colonists, of Russian birth, are barred from entrance into the United States. The school children are too young to assert their independence. Today Colonia Rusa is largely composed of these two extremes of age.

SOUTH AMERICA

Settlement of the Tacna-Arica Boundary Dispute. The governments of Chile and Peru have agreed to settle the Tacna-Arica dispute by dividing the disputed territory. The actual treaty has not yet been concluded, but both governments have accepted as the final basis for the solution of the problem the stipulations proposed by the President of the United States in his note of May 14 addressed to the two governments.

The accompanying map has been prepared to show as accurately as available information will permit the region of the new boundary. The Tacna-Arica section of the La Paz sheet of the Society's Millionth Map of Hispanic America has been used as the basis of the compilation. This section of the sheet contains all the surveys and supplementary information available in 1922 when the sheet was published. It was reproduced by the U. S. Geological Survey on the scale of the original drawings (1:500,000) and used by the Special Boundary Commission, Tacna-Arica Arbitration, as the base map for their studies of the disputed northern boundary of the province of Tacna. To this compilation has now been added the survey of the region of this disputed boundary made by the Peruvian section of the above commission in 1925–1926—a detailed topographic survey based on triangulation tied to astronomically located points of which the longitude was determined by wireless time signals.

According to the stipulations suggested in the President's note, the Tacna department of the province of Tacna is to belong to Peru, the Arica department to Chile. The dividing line, however, is not to follow the old boundary between these districts.

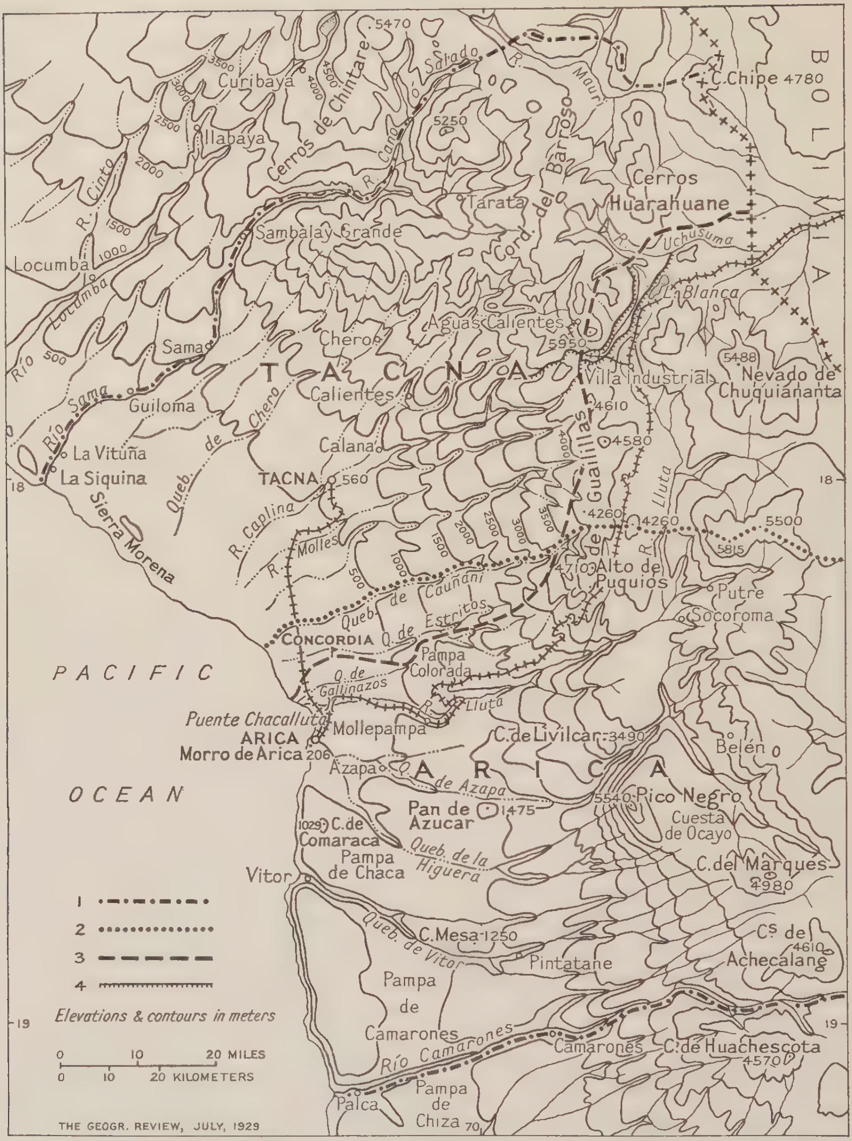

FIG. 1—Map showing the area concerned in the Tacna-Arica settlement. Numbers have reference: 1, boundaries of disputed provinces as defined by Chile; 2, old boundary lines between Tacna and Arica; 3, ten-kilometer line; 4, canals of Uchusuma and Mauri. Scale approximately 1 : 1,500,000.

It will "start at a point to be designated with the name 'Concordia,' situated ten kilometers north of the bridge over the River Lluta, and shall continue parallel to the Arica-La Paz Railroad, following, as far as possible, the topographic features which may make easier the demarcation of the line." The sulphur deposits of Tacora (presumably at Aguas Calientes, reached by a branch railroad from Villa Industrial on the Arica-La Paz Railroad) are to remain in Chilean territory; while "the canals of Uchusuma and Mauri, also known as Azucarero" (indicated on the

Peruvian survey of the Tacna boundary zone mentioned above as the Uchusuma and Azucarero canals) remain the property of Peru. This ownership by Peru is to be extended even to such sections of the canals as pass through Chilean territory and "includes the right to widen the actual canals, change their course, and appropriate all waters that may be collectible in their passage through Chilean territory." The boundary is to pass through the "center of Laguna Blanca, dividing it into two equal parts." The boundary is to be demarcated and monumented by a joint commission consisting of one Peruvian and one Chilean engineer and their assistants. Disagreements are to be decided by a third person designated by the President of the United States whose decision shall be final.

The government of Chile is to maintain in the Department of Arica the franchise granted by the government of Peru in 1852 to the Arica-Tacna Railroad Company, and is to grant to and construct for Peru within 1575 meters of the Bay of Arica a wharf, customhouse, and station for the Arica-Tacna Railroad "where Peru shall enjoy independence within the most ample free port."

Demarcation of the line will present certain difficulties. The bridge across the River Lluta referred to in the locating of "Concordia," the starting point of the boundary, is presumably the Puente Chacalluta, although this is not clearly indicated in the President's stipulations; and the line will proceed from this point to the Pacific and to the Bolivian border parallel to the Arica-La Paz Railroad and distant 10 kilometers from it except for minor adjustment to suitable topographic features and such major adjustments as the stipulations demand in certain sections. It will be seen from the map that, once this line reaches the Sierra de Guailillas, only minor adjustments will be necessary to keep the boundary to the main crest of the Sierra for a considerable distance. West of the Sierra de Guailillas, however, to keep the line parallel to the railroad will necessitate a highly arbitrary line which will cross and recross the upper tributaries of the Quebrada de Estritos and the lower portion of the Quebrada de Gallinazos. It is probable that the line finally established will lie between these two *quebradas*. The construction of the boundary so as to include the sulphur deposits of Tacora in Chilean territory will also involve considerable study and negotiation, as will its adjustment so as to fulfill the stipulation that it is to cross Laguna Blanca dividing it into two equal parts, since the *laguna* lies close to the railroad far south of the 10-kilometer line. Eastward from Laguna Blanca to the Bolivian border the course of the line is not mentioned in the stipulations. It would seem also that the rights of Peru in the ownership and maintenance of the Uchusuma and Mauri canals where they pass through Chilean territory, especially as regards the widening of them and the changing of their courses, must be definitely defined and limited if future difficulties are to be avoided. Westward from the Sierra de Guailillas to the Pacific Ocean too little information is available on present property holdings to permit any comment on the adjustment of the boundary to property lines.

The settlement of the Tacna-Arica boundary dispute leaves only two boundary problems of major importance in South America—the Bolivia-Paraguay dispute in the Chaco and the Peru-Ecuador dispute east of the Andes. These two disputes, however, involve, respectively, about 127,000 and 126,000 square miles. Excellent progress has been made since the beginning of the century in the settlement of boundary disputes throughout Hispanic America. Dr. Manfred Langhans-Ratzeburg, in "Die strittigen Gebiete der Erde seit 1900" (*Petermanns Mitt.*, Vol. 75, 1929, pp. 136–140), offers brief notes, accompanied by footnote references to various publications on the different disputes, on the status of all the boundary disputes in Hispanic America and the West Indies in 1900. He lists thirty-four disputes in 1900. Many of these were of little consequence, but a large number were of major importance. Of all these only thirteen now remain unsettled.

EUROPE

Southeastern France: Rhone Valley and Alps. Southeastern France is the unique possessor of two institutions devoted exclusively to regional geographical study—the well known Institut de Géographie Alpine at Grenoble, organized by Raoul Blanchard and now in its twenty-third year, and the recently established Institut des Études Rhodaniennes at Lyons. "Coordonner les recherches d'ordre physique et économique concernant le Rhône et ses principaux affluents ainsi que la voie de passage et la zone d'activité que constitue le couloir rhodanien (vallée de la Saône et du Rhône). Organiser, sur cette important région française, et européenne, une enquête scientifique permanente, susciter des courants d'idées, créer entre les chercheurs et aussi entre les foyers d'activité et de pensée dispersés au long de cet axe rhodanien un organe de liaison efficace" is the announced object of the Institute at Lyons. Its results are published in an annual statistical bulletin and an annual volume of "études et travaux." Thanks to the able direction of André Cholley, called to the Sorbonne at the end of 1927, and his successor at Lyons, André Allix, *Les Études Rhodaniennes* has already taken its place as an important addition to periodical geographical literature. The first volume, 1925, appropriately dealing with the entire river, is the monograph "Le Régime du Rhône," by Maurice Pardé. No such comprehensive work on the Rhone had been available hitherto. Moreover, as the study of a river which "combines all the hydrological régimes of western Europe" it has a particular value for comparative purposes. The succeeding volumes of *Les Études Rhodaniennes* (for 1926, 1927, 1928, and Fasc. 1, 1929) follow the usual plan and contain several articles and contemporary chronicle and review. Special reference might be made to the paper "Quelques remarques sur la culture et le commerce des fruits dans la banlieue de Lyon," by M. Cholley himself (Vol. 3, 1927), noteworthy for its truly geographical quality.

One of the most distinguishing features of the Rhone region is its rich variety. This is well brought out in "Plaines et bassins du Rhône moyen entre Bas-Dauphiné et Provence," by Daniel Faucher of the University of Toulouse, a monograph in characteristic French style. It treats of that part of the Rhone where the valley narrows and transition is made between the Midi and the north and where also converge influences from the Alps and the Central Massif (see the analysis by L. Gallois in *Ann. de Géogr.*, Vol. 37, 1928, pp. 177–180). Even in this region one notes the "drought or fear of drought" which conditions agriculture in the Midi. Irrigation is one of the major problems in the much discussed plans for improvement of the Rhone (Auguste Pawlowski: Transformation de la Provence inféconde, *La Nature*, No. 2798, 1928, Dec. 1, pp. 492–497). It is hoped to reclaim the desert areas of Camargue and Crau. "The Camargue . . . is at present a sparsely populated region, where mankind is repelled by a spread of malaria-breeding salt marshes, where the impression produced on the wanderers is that of a solitude more impressive than of the ocean, and where droves of cattle, goats, and horses, wander as wild and as free as on the plains of Texas" (R. D. Oldham: The Portolan Maps of the Rhone Delta, *Geogr. Journ.*, Vol. 65, 1925, pp. 403–428. On the historical problem see also his paper, "Problems of the Rhone Delta," *Nature*, Vol. 116, 1925, pp. 16–19, 52–54, and 100–102). The primitive economic state of the Camargue and the stony plain of the Crau is seen in the predominance of transhumance in these areas, a good description of which may be found in "Le mouvement économique: L'agriculture," by Paul Masson, a recently published volume of "Les Bouches-du-Rhône" (Encyclopédie départmentale publiée par le Conseil Général avec le concours de la Ville de Marseille et de la Chambre de Commerce sous la direction de Paul Masson, Vol. 7, Marseilles and Paris, 1928), a mine of information on the Rhone delta country.

Studies of the Rhone Valley and the French Alps naturally overlap. Such is advisedly the case in M. Cholley's "Les Préalpes de Savoie (Genevois, Bauges) et leur avant-pays" (Paris, 1925). This monograph of 755 close-set pages is a most thorough-going piece of work. It deals with the Genevois and Bauges massifs of the Prealps (on the use of this term see Emmanuel de Martonne: Les Alpes, 1926, p. 204) and their "avant-pays" extending to Lake Bourget and the Rhone and constituting a passageway between the Jura and the Alps. M. Cholley is concerned with demonstrating the individuality of the region as a unit and with elaborating the diversities and contrasts within the unit. "Like most regions situated on the border of high massifs it is a privileged country of great variety, exhibiting infinitely more shades of expression than either the high mountains or the neighboring plains." This is the underlying thought of the discussions of morphology, climate, man, natural conditions, and types of life from ancient to modern times that form the major categories of the treatise, a convenient summary of which is given by M. de Martonne in *Annales de Géographie* (Vol. 35, 1926, pp. 363–367). The political and economic history of Savoy, thanks to its situation, presents no little of interest; and one point in particular may be noted here: M. Cholley's treatment of that problem in political geography presented by the zonal régime to which the northern part of Savoy was subjected. The volume suffers one serious drawback. While it contains a number of small sketch maps and diagrams—there are no less than six on distribution of the forest lands—there is no good general map: one on a scale commensurate with the high detail of the text is sorely needed. An index also is greatly to be desired.

Of the *Revue de Géographie Alpine* we need only say here that it continues its fruitful production of local studies of the French Alps. Among its papers of wider scope that have recently appeared are a series of industrial studies by Professor Blanchard, the latest of which are "L'industrie des chaux et ciments dans le Sud-Est de la France" (Vol. 16, 1928, pp. 255–376) and "La grande industrie chimique dans la France du Sud-Est" (*ibid.*, pp. 561–624) and a paper by Jeanne Bouchet, "La culture du blé dans les Alpes françaises, 1913–1924" (*ibid.*, pp. 625–667).

In all these studies the great importance of the climatic factor is in evidence; and we cannot conclude this note better than by reference to the admirable work, "Le climat des Alpes françaises," by Ernest Bénévent (*Memorial de l'Office National Météorologique de France No. 14*, Paris, 1926), who takes up the climatic elements in the order: winds, temperature, precipitation, and brings them together in his conclusion "Limite climatic," in which he dwells on the importance of the climatic boundary separating the French Alps into northern and southern divisions. The rarity of studies on this order for mountain regions enlarges its merit. One looks eagerly to such data as are given, for instance, on the snowfall, the snow cover and its influence on the life in the mountains, and the intensity of precipitation in the high mountains. Bénévent believes the greatest precipitation is to be attributed to the Diosaz Valley on the southwestern flank of the Aiguilles Rouges where at the zone of maximum precipitation the rainfall is estimated at 5000 millimeters (200 inches). He lays stress on the secondary rôle played by mere altitude and on the absolute importance of situation.

The Economic Regions of France. On October 29, 1927, the Twentieth Economic Region of France, comprising Upper Alsace and the old province of Franche-Comté, was formally inaugurated (see Pierre Mandoul: La région économique Franche-Comté-Haute-Alsace, *Rev. Écon. Internatle.*, Vol. 4, 1928, pp. 265–287). "Regionalist" sentiment in France has been growing since the pre-war period (see *Geogr. Rev.*, Vol. 7, 1919, pp. 115–116; Vol. 14, 1924, p. 144). It represents a reaction against the tendency toward excessive centralization that has been characteristic of French political and economic life for centuries. The conception had arisen, as Henri Hauser has put it, of France "as a sort of economic nebulosity, swept along in the orbit of

Paris." By the outbreak of the war, however, this conception was being abandoned, partly as a result of the rapid increase in population and influence of the provincial cities and also in no small measure owing to the work of geographers, especially of Vidal de la Blache and his disciples of the regional school.

The war contributed directly toward the definite organization of economic regions (see Henri Hauser: Le problème du régionalisme, histoire économique et sociale de la guerre mondiale, Publications de la Dotation Carnegie pour la Paix Internationale, Paris and New Haven, 1924). A long period of discussion, mutual adjustment of conflicting interests, and experimentation, however, had to be gone through before "the organization could be considered even approximately complete." This status was reached by the summer of 1921. The regional organizations represented by their councils perform varied tasks. They themselves undertake and encourage the universities and other institutions in carrying out studies relating to manufacturing, commerce, public works, power resources, the tourist industry, and other matters affecting the economic status of their respective regions. They enter into negotiations with the regional councils of neighboring regions over points of common concern. They establish laboratories, museums, and institutions of research, and they publish periodicals. One region has undertaken the compilation of a statistical and economic atlas.

At first, Franche-Comté was assigned to the Twelfth Economic Region, which comprises Burgundy and has its center at Dijon. This arrangement was not satisfactory to the Chamber of Commerce of Besançon which, as a consequence, persisted for several years in standing aloof. Finally the matter was adjusted by the creation of the new Twentieth Region. The organization of this region is of particular interest, since the districts which are today included in it "during a period of nearly twenty-two centuries have been almost continually united by historic ties . . . particularly ties of an economic order . . . ." Even "the war of 1870 and the treaty which brought it to an end did not succeed in destroying the solidarity of these two districts (Upper Alsace and Franche-Comté). The new frontier was, without doubt, a difficult barrier to cross, and the environs of Belfort assumed a strategic importance little favorable to the growth of commerce. In spite of this the industries of Mulhouse established branches in Belfort and on the western slopes of the Vosges." The maintenance of the age-old economic connection between Upper Alsace and Franche-Comté and the reaffirmation of the connection in the inauguration of Twentieth Region certainly owes something to a geographic factor: the Pass of Belfort, that famous gateway of eastern France that offers a ready avenue between Vosges and Jura from the valley of the Rhine into that of the Saône.

A Recent Study of Urban Geography in Sweden. The results of an important study of certain towns in the Mälardalen area of Sweden made in 1925–1926 by Dr. John B. Leighly have recently been published by the University of California ("The Towns of the Mälardalen in Sweden: A Study in Urban Morphology," *Univ. of California Publs. in Geogr.*, Vol. 3, No. 1, Berkeley, Cal., 1928). The area investigated formed the nucleus of the Swedish nation. It lies about the great island-dotted Lake Mälar, at whose outlet to the Baltic stands the city of Stockholm. The particular towns studied range in population from about 800 to just over 30,000 inhabitants, the best known of the group being Upsala, with a population of 30,255.

Dr. Leighly regards towns "as landscape features of cultural origin, whose forms have their present character because of the continuous action of cultural forces, as the natural features of the landscape are the products of natural forces acting through time," "landscape" here being used in the special sense in which the author's colleague, Professor C. O. Sauer, employs the term. Besides illustrating a point of view regarding objectives in geographical research that is finding favor among not a few American geographers, Dr. Leighly's monograph contributes observations of fact that are of broad interest. The manner in which the particular towns studied have acquired the physical forms they now present is doubtless typical of many other centers in northern Europe.

Unlike the Mediterranean folk, the early Germanic peoples were not builders of cities, and the way in which cities have grown in northern countries during medieval and modern times has been influenced to no small degree by ideas that have come in from the south. The existing form of the Swedish town is thus the resultant of an interplay of two cultural forces, the indigenous and the exotic. When, during the Middle Ages, the beginnings of commerce and of ecclesiastical organization gave rise to the concentration of population in urban groups, the towns carried over many of the structural characteristics of the agricultural village. In the village the farm unit consisted of a dwelling house with a number of subsidiary structures, each serving a different function and standing well apart from its neighbors. A similar subdivision of functions was preserved in the towns, and, indeed, not until the nineteenth century did there come a "change toward a 'modern' type of occupation of the land, with the functions of the establishment concentrated in a single large house facing the street."

Since Sweden is largely forested, most of the houses there are made of wood. This creates a fire hazard—somewhat diminished in the agricultural villages by the dispersal of the buildings. "Mediterranean urbanism, [on the other hand,] was based on a relatively fireproof building culture, which permitted a close arrangement of buildings. The idea of close crowding of numerous dwellings was adopted by the Northerner in the founding of the settlements to be made under the influence of the urban culture, but he retained his wooden houses." Conflagrations were the inevitable result. At one time or another most of the towns were razed in whole or in part by fire. This made possible more frequent changes, not only in architectural styles but in street plan, than would have been possible if the urban form had become "petrified" through fireproof construction.

Town planning seems to have been unthought of in medieval Europe. The pattern of houses and streets grew irregularly, in conformity with the topography and with considerations of convenience. The Renaissance brought a passion for classic regularity and rectangularity. After about 1600 a Swedish town, when it had burned, was reconstructed with rectangular streets, and new quarters were laid out on rectangular lines. Recently, in Sweden as elsewhere, there has been a reaction. Curving streets are now in favor. We thus find that in many towns "the nucleus, thanks to fire and to the engineers of the seventeenth, eighteenth, and nineteenth centuries, is rectangular; the outer zones display the winding streets and irregular blocks of the new medievalism, together with the outposts of the towns which have grown without plans."

AFRICA

Exploration for Stock Routes in the Kalahari Desert. The Kalahari, though ill-defined, is estimated to comprise some 400,000 square miles—an area about three-quarters the size of the Union of South Africa. It "intrudes itself by pressing its borders on each of the separate states of South Africa, and the conquering of even these borderlands has been a regrettably slow process . . . its center, located only a couple of hundred miles to the west of Palapye Road, has not even been examined" (A. L. du Toit: The Kalahari and Some of Its Problems, *South African Journ. of Sci.*, Vol. 24, 1927, pp. 88–101). In 1928, however, a concerted attack was made on this unknown interior, three expeditions organized by the administration of the Bechuanaland Protectorate participating. The objective was to discover a practicable route for the export of cattle from the Ghanzi district on the north-western border of the desert to the Rhodesian railway and Katanga. Like similar expeditions in Australia, the survey of the Canning stock route in Western Australia

(1906–1907) for instance, these expeditions have been productive of interesting geographical results.

To understand the objective of the expeditions one must go back thirty years to the founding of Ghanzi, one of Cecil Rhodes's colonies. The story of the first settlers, the twenty-five English and Dutch families who traveled over the waterless Kalahari by way of Khama's capital, Palapye Road, has been told by "one of them" in "The Great Ngami Trek" in *The Round Table*, No. 65 (Dec., 1926, pp. 81–101). It is an epic admirably told and above all touching in its tribute to South Africa's great colonizer. "After the Great Ngami Trek" in *The Round Table*, No. 74 (March, 1929, pp. 325–341) gives an equally luminous picture of life in Ghanzi today with the population numbering well over a hundred. "An airman hovering over our little colony would have a varied view. To the north and north-east he would see the bush-covered rocky kopjes, green and grey, which separate the Lake Reserve from the Ghanzi district with its rolling open plains, its tracks of bush, its ridges and valleys and its pans girt with trees; the homesteads, too, scattered about from one to fifteen miles apart, connected by wagon trails, each with its cattle kraal and its bit of garden, and here and there a windmill. The plains would also meet our airman's eye, with their troops of eland, wildebeeste, gemsbok, hartebeeste and ostriches, and the cattle and the flocks of sheep and goats in the neighbourhood of the farmhouses, a truly peaceful pastoral landscape. Here and there he would descry patches clear of game, the result of some raid by Bushmen or wild dogs. Near the centre of the picture and away from the other buildings, the magistracy premises would stand out with our newly erected meteorological tower. A self-contained little territory it is, still in a half wild state. There is not even a village, let alone a town, or a railway."

Ghanzi is excellent ranching country, and cattle are the mainstay of the little colony today but under the handicap of extreme transportation difficulties. A favorite route to the east has been via Lake Ngami and Victoria Falls; but the tsetse fly has appeared, and the establishment of a new track has become necessary if the Katanga market is to be retained. During the rains in the early months of 1928 Lieutenant H. Beeching with camel and ox transport pioneered a new route from Ghanzi to Metsematluk and Molepolole, which is connected by motor road with the railway. At the same time a six-wheeled lorry was despatched on a more northerly route from Serowe to Maun via the Botletle River. Lieutenant Beeching's expedition found water in limestone pans. The almost continuous limestone formation suggested the possibility of establishing an all-weather motor road; and accordingly in June, 1928, an expedition under Captain B. E. H. Clifford left Mahalapye on the Rhodesian railway with two motor lorries on the 400-mile trek to Ghanzi, picking up Lieutenant Beeching's trail about half-way across. Little water was found, since this was the dry season; but Captain Clifford ascertained that by digging through the limestone a shale is encountered which if penetrated to a depth of 10 to 15 feet will give a perennial supply of water (see "Bechuanaland Protectorate, Rept. for 1927–28" *Ann. Colonial Repts. No. 1424*). Grazing and water prospects appear favorable along this new track, but a great drawback to motor transport lies in the great number of punctures which render this means of travel decidedly uneconomic. Solid tires, on the other hand, bore too deeply into the sand. Captain Clifford describes his journey and a supplementary one to prospect a new fly-free route to Victoria Falls in the *Geographical Journal*, April, 1929, pp. 342–358.

Aerial Survey in Northern Rhodesia. The Rhodesian Congo Border Concession holds the mineral exploration rights over 52,000 square miles in Northern Rhodesia, an area lying immediately south of the Katanga-Rhodesia boundary and extending from the Angola frontier on the west to beyond the Northern Rhodesia Railway on the east. In all probability this is a rich mineral region; and in order to obtain, expeditiously, a basis for intensive prospecting, the Aircraft Operating Co. was engaged to photograph 20,000 square miles of the concession. With the exception of the Rhodesia-Congo boundary and several of the chief rivers, the country was unsurveyed and so undeveloped that it was necessary to clear forty-three emergency landing fields before the flights commenced. Since experience had shown that the presence of salts in shallow soil over copper outcrops prohibits tree growth, the location of *dambos*, open spaces in the forest, was considered especially important, as a means of enabling the Company's geologists to concentrate their efforts on the more favorable localities (see G. L. Walker: Surveying from the Air in Central Africa, *Engineering and Mining Journ.*, Vol. 127, 1929, Jan. 12, pp. 49–52).

Although this aerial survey was primarily for the location of mineral deposits, coöperation in the field between the Rhodesian Congo Border Concession and the Imperial Forestry Institute resulted in a much wider study of the resources of the region. These findings have been published as Number 9 of the Oxford Forestry Memoirs (R. Bourne: Aerial Survey in Relation to the Economic Development of New Countries, with Special Reference to an Investigation carried out in Northern Rhodesia, Oxford, 1928). Mr. Bourne employed the method of familiarizing himself with local conditions on the ground, including a motor survey of 142 miles of road, and of then applying his deductions to the photographic mosaic. In this particular instance where climate and topographic conditions were favorable and the soils were residual he was able to draw definite correlations between the underlying rock, the soil, and the vegetation types. Weighing the findings of this survey and of a previous one in Burma (see *Geogr. Rev.*, Vol. 16, 1926, p. 145; and *Burma Forest Bull. No. 13*, 1926), Mr. Bourne concludes that, if the specialized knowledge of agriculturists, foresters, pedologists, and geologists is brought to bear on the problem in the field, a working plan for the development of an area can be easily and satisfactorily arrived at.

In addition to the already unusually wide scope of this survey, the government of Northern Rhodesia, interested in the navigation possibilities and water resources of the upper Zambezi River, has ordered a special survey of that river from Livingstone to a point some 400 miles up the stream and including the Lungwebungo River as far as the Angola boundary and some 150 miles of the Kabompo River (*African World*, No. 1300, Vol. 100, 1927, Oct. 8, p. 440).

The Demarcation of the Boundary between Jubaland and Kenya. In accordance with agreements made in 1919 and 1920 Jubaland, lying to the west of Italian Somaliland, was formally transferred from British to Italian sovereignty on June 29, 1925 (see *Geogr. Rev.*, Vol. 14, 1924, p. 150). During 1926–1927 the boundary between Jubaland and Kenya was surveyed and demarcated by a joint British and Italian commission. The work of the commission is described by the Senior British Commissioner, Lieutenant Colonel L. N. King, in a paper read before the Royal Geographical Society last year and supplemented by notes on the geography of Jubaland by Captain E. H. M. Clifford, Assistant Commissioner (*Geogr. Journ.*, Vol. 72, 1928, pp. 420–442). The line runs for a distance of 681 kilometers generally southward from the Daua River to the Indian Ocean. Since the country traversed was difficult of access and but little known, the commission was obliged to carry out a work of genuine exploration. As Sir Charles Close, President of the Royal Geographical Society, remarked in the discussion of the papers, most international boundaries in Africa pass through out-of-the-way regions; the series of boundary commissions "which started after 1884" has been "one of the chief means by which we have been enabled to develop, understand, and arrive at the proper appreciation of the real geography of Africa." The Jubaland-Kenya line was marked not only by the usual pillars and cairns but by a lane about twelve feet broad cut through the brush. It was thought that "such a line would be unmistakable to the local tribes, that the brush was of a very slow-growing variety, [and] that the lane once cut would undoubtedly be kept open by natives driving their stock between pasturages. . . ." Since 1926 not only has a considerable extent of the lane been opened up to motor traffic but other automobile roads have been developed.

Captain Clifford comments on the "featureless flatness" of the landscape in Jubaland. The northern part of the country consists of a plateau bounded on the north and south by escarpments and reaching a maximum altitude of about 700 meters. The central and southern parts form an undulating plain, with low hills along the coast. "Thorn bush, on the average about 11 to 12 feet high," covers most of the area, although there are forests in the south. As Jubaland lies under the equator, there are two rainy seasons each year. The mean annual rainfall, however, is only about 7½ inches, and, as in nearly all dry countries, the rain is highly irregular, often coming in spasmodic downpours. Water is obtained from scattered wells or, after rain, by digging below the surface of torrent beds. Captain Clifford believes that there are no springs. The population consists for the most part of Somali nomads and semi-nomads who have come from the east, driving out the Galla negroes. "The Somali is essentially a camel-owner, and the northern half of Jubaland is good camel country. But from about 1° N. southwards a variety of 'tabanus' fly, called 'baal,' appears in swarms with the rains." Most camels bitten by these flies die. "Consequently one only sees an occasional camel in the southern half of the country, and the stock there is entirely cattle, fat-tailed sheep, and goats." Official Italian statistics give for the area of Jubaland about 90,000 square kilometers, 34,750 square miles, and for the population approximately 100,000. Kismayu, the port and principal town, had 3600 inhabitants in 1925. Only about 460 square miles are believed to be susceptible of cultivation without very elaborate irrigation. (The Italian Ministry of Colonies has recently published a large volume on Jubaland, "Oltre Giuba," prepared under the direction of the High Commissioner, Corrado Zoli, and summarized in *Le Vie d'Italia*, Vol. 34 (6), 1928, pp. 24–32).

ASIA

Man and Nature in Central Arabia. In a volume entitled "Arabia of the Wahhabis" (Constable & Co., London, 1928) H. St. J. B. Philby completes the narrative of his explorations and diplomatic mission to Ibn Sa'ud of 1917–1918. At the close of an earlier work, "The Heart of Arabia" (see *Geogr. Rev.*, Vol. 13, 1923, pp. 484–485), the story breaks off upon Philby's return to Riyadh, the Wahabi capital, after a journey into southern Nejd during which a large tract of previously unexplored country was visited. "Arabia of the Wahhabis" opens with a striking account of the author's sojourn in Riyadh during Ramdhan, the month of fasting, which in 1918 happened to fall during the torrid heats of midsummer. Early in August Ibn Sa'ud, with "the full approval and active support of the British Government," embarked upon a campaign against Ibn Rashid, the Shammar emir of Haïl in northern Nejd, hereditary enemy of the house of Ibn Sa'ud and ally of the Turks (see Alois Musil: Northern Negd, *Amer. Geogr. Soc. Oriental Explorations and Studies No. 5*, New York, 1928, pp. 250–252). Part of the time in company with Ibn Sa'ud, Philby made his way northward through the little-known region of Washm and into Qasim, then Ibn Sa'ud's northernmost province. He tells us much of life in the twin oasis cities of Qasim, 'Anaiza and Buraida. On entering the former, he writes, "It seemed to me that I had stepped suddenly out of barbarism into a highly civilized and even cultured society, where the stranger within the gates, far from being an object of aversion and suspicion, was regarded as the common guest of the community . . ." Buraida is only sixteen miles away. "Yet neither remorse nor enlightenment born of travel will ever wean the citizen of Buraida, when at home, from the bigotry in which his city has grown great among the cities of Arabia."

On October 2, after a visit to northern Qasim, Philby received the unexpected news that the British Government had reversed its policy in regard to Ibn Sa'ud's campaign against Haïl. His mission thus terminated, Philby was obliged to bid farewell and march down to Kuwait; and three years were to elapse before Haïl was finally incorporated into Ibn Sa'ud's territories. On the way to Kuwait the explorer saw from a distance in the desert, "in surroundings utterly dismal and unattractive, 'Artawiya, a great town of 10,000 inhabitants that had sprung into existence since 1912. The first *Ikhwan* colony to be founded, it is an epitome of the Wahhabi revival, which, under the wise and skilful guidance of Ibn Sa'ud, has brought the boon of peace, security and, in a measure, unity to Arabia."

The main value of Philby's now completed work lies in the insight it gives us into Arab life. The explorer's maps and notes, however, have also made possible the development of a general hypothesis regarding the physiography of Central Arabia. This hypothesis, based fundamentally on the reports of Philby but supplemented by reference to the observations of Doughty, Huber, Raunkiaer, Mackie, and Cheesman, is presented by Raoul Blanchard in "Le relief de l'Arabie centrale" (*Rev. de Géogr. Alpine*, Vol. 14, 1926, pp. 765–786). Blanchard compares the physiographic history and resulting relief of Central Arabia with those of central and northern France. Western Nejd, a tract of ancient crystalline rocks and of eruptive rocks of recent age, he styles the central massif of Arabia on the analogy of the Massif Central of France. Here the general trend of both granitic ridges and more recent eruptive masses from southwest to northeast suggests that the massif may have been broken by faulting associated with the tectonic movements that gave birth to the Red Sea. The massif as a whole appears to be the core of a vast dome or bulge that is cut across on the west and southwest by the coast ranges of the Hejaz and Asir but farther to the northeast, east, and southeast constitutes the structural element that determines the major relief features of inner Arabia. Over the central massif, denudation has stripped away the Secondary and Tertiary formations, laying bare the ancient basal crystalline foundation. Farther out from the center of the bulge, however—to the northeast, east, and southeast—the Secondary and Tertiary strata are still intact. They dip gently away from the massif and, as in the Paris Basin, give rise to a well defined and characteristic sequence of concentric scarps, cuestas, and lowlands. The original drainage pattern of the dome is preserved in consequent valleys running northeast, east, and southeast, directly through the cuestas. The lowlands between and parallel with the cuestas are obviously subsequent valleys eroded out along belts of less resistant rock. Most of the oases lie in these lowlands, and the greater part of the population of Nejd dwells there rather than farther west among the barren and forbidding rocky hills of the central massif.

Upon a diagrammatic sketch drawn after Philby's maps Blanchard shows the westward-facing scarps of the cuestas. He places their northernmost extremity at about latitude 27°, to the east of Buraida in Qasim. Alois Musil's map of northern Arabia published by the American Geographical Society, however, shows what appears to be a well developed series of scarps, cuestas, and lowlands still farther north, between the Nefud desert and Mesopotamia.

A further attempt at geographical synthesis on the basis of the fragmentary evidence available regarding the surface of northern Arabia takes the form of a map by Dr. Adolf Käselau (see *Petermanns Mitt.*, Vol. 74, 1928, pp. 341–342, and Pl. 39) showing a classification of the land according to its relative value to the Bedouins. Four types of surface are differentiated: (1) *harras*, or volcanic tracts covered by eruptive rocks of recent origin; (2) other "regions of hardship" (Kümmergebiete); (3) neutral regions; and (4) favored regions. The last-named include the sandy deserts (Nefuds), upon which there is an abundant bushy vegetation, the oases, the valleys of the principal wadies, and a strip along the Persian Gulf.

POLAR REGIONS

Bouvet Island. In his article "Modern Norwegian Whaling in the Antarctic," printed in this number of the *Review* Major Isachsen briefly refers to the work of the *Norvegia*. On November 30, 1927, this vessel, fitted out by Consul Lars Christensen of Norway for a commercial and scientific voyage, sighted Bouvet Island in latitude 54° 26′ S. and longitude 3° 24′ E. The following day the captain landed and took possession in the name of Norway. Within the next few days the island was circumnavigated; soundings, sketches, and photographs were taken; and landings were effected in a few places. In appearance the island, which is of volcanic origin, is pentagonal in shape, being about 7½ by 9½ kilometers. Its snow-clad sides rise evenly to a central plateau, the highest points on which are above 900 meters. Practically no vegetation and only the lowest forms of animal life were found. The surrounding water and sea were teeming with life, and a number of fur seals were killed by the expedition (see Haakon Mosby: Bouvet-øen og "Norvegia" ekspedisjonen 1927–1928, *Naturen*, Vol. 52, 1928, pp. 321–333). The *Norvegia* remained in the vicinity until January 1, 1928, making observations.

In January, 1928, the British Colonial Office announced that the whaling concession "to the territorial waters of Bouvet and Thompson Island" had been let to a Norwegian firm. The Norwegian government pointed out that the island had been taken possession of in the name of Norway; and on November 19, 1928, it was announced that the British claim to Bouvet Island was waived in favor of Norway. Although, in 1739, in this general neighborhood Bouvet sighted land which was subsequently seen by several explorers and unsuccessfully sought after by others, the first landing was made by the English Captain Norris who in 1825 sighted two islands, one in latitude 54° 15′ S. and longitude 5° E. and one in 53° 56′ S. and 5° 30′ E., which he named Liverpool and Thompson Islands respectively. He landed upon Liverpool Island. The British claim to Bouvet Island was based on Captain Norris' discovery. Uncertainty prevailed as to the exact number and location of the islands until 1898 when a German deep-sea expedition on the *Valdivia* failed after much searching to find any of the islands in the positions assigned them by their discoverers but did locate land in latitude 54° 26′ 4″ S. and longitude 3° 24′ 2″ E., which was named Bouvet Island. It was this island that was taken possession of by the *Norvegia* in 1927. Since exact location was difficult to ascertain on account of prevailingly bad weather of the region, it had been supposed that the Bouvet Island of the *Valdivia* expedition was the same as either Liverpool or Thompson Island of Captain Norris. The assumption has been questioned by Consul Bjarne Aagaard in his pamphlet "The *Norvegia* Expedition and Bouvet Island" (Oslo, 1928). An analysis of the matter is made in the *Geographical Journal* for December, 1928 (pp. 537–546), with the conclusion that there seems to be no reasonable grounds for doubting the identity of Liverpool Island and Bouvet Island.

The existence of Thompson Island in the same neighborhood still seemed possible, and therefore the *Norvegia* in December, 1928, after visiting Bouvet Island and preparing for the establishment of a meteorological station there, searched for eight days but, finding no land, came to the conclusion that Norris had probably seen an overturned iceberg (see Bjarne Aagaard: Antarctic Whaling and Exploration, *Scottish Geogr. Mag.*, Vol. 45, 1929, No. 2, pp. 65–81).

OBITUARY

E. Lester Jones. Colonel E. Lester Jones, director of the U. S. Coast and Geodetic Survey, died in Washington on April 9, 1929, in the fifty-third year of his age. Colonel Jones's administration from his appointment in 1915 was a notable achievement, as is shown by the annual report of the Bureau for 1928 in which is summarized the progress of the last ten years. During this time nearly half of the coasts of the United States from Canada to the Mexican border has been surveyed; in southeastern Alaska all the through steamer routes are now charted, and the original survey of the outside coast of this region has been completed; "1926 was the first year in our history in which not a single wreck occurred in Alaska waters." An adjustment of the triangulation nets of the western half of the United States has been accomplished, involving the results of 13,000 miles of arcs of triangulation; in coöperation with the Geodetic Survey of Canada triangulation has been extended from the United States through the coastal waters of British Columbia and Alaska; a readjustment has been made of the precise-level net, as a result of which it appears that the Pacific Ocean along the western coast of the United States is on an average about two feet higher than the waters of the Gulf and the Atlantic along the southern and eastern coasts. The first magnetic survey of the United States has been substantially completed. In addition to the prosecution of the regular services with improved technique and production, the Coast and Geodetic Survey has embarked on new tasks—the production of aerial navigation maps of the United States, investigations in seismology, current surveys of the principal harbors of the country, and maintenance of the variation-of-latitude station at Ukiah, Cal.

Constant effort to promote the work of the Bureau appears in Colonel Jones's writings, for instance, the U. S. Coast and Geodetic publications, "The Neglected Waters of the Pacific Coast: Washington, Oregon, and California" (*Special Publ. No. 48*, 1918), "Safeguard the Gateways of Alaska: Her Waterways" (*Special Publ. No. 50*, 1918), "Earthquake Investigation in the United States" (*Serial No. 304*, 1925), just as he earlier pleaded for the development of Alaskan resources while acting as Deputy Commissioner of Fisheries in his "Report of Alaska Investigations in 1914."

John William Harshberger. Dr. Harshberger, professor of botany in the University of Pennsylvania, died in Philadelphia on April 27, 1929, in the sixty-first year of his age. His special field was plant geography and ecology. He had traveled extensively; but his numerous writings (see the bibliography in "The Life and Work of John W. Harshberger, Ph.D.; An Autobiography," Philadelphia, 1928) related mainly to North America, his *opus magnum* being the "Phytogeographic Survey of North America" (1911) in "Die Vegetation der Erde" Series (see the review by R. M. Harper; *Bull. Amer. Geogr. Soc.*, Vol. 45, 1913, pp. 38–42). His publications also include "The Vegetation of South Florida" (*Trans. Wagner Free Inst. of Sci. of Phila.*, Vol. 7, Part III, 1914); "The Vegetation of Nantucket" (*Bull. Geogr. Soc. of Philadelphia*, Vol. 12, 1914); "The Vegetation of the New Jersey Pine-Barrens" (1916); "A Comparison of the Alpine Regions and Vegetations of Eastern America, Norway and Switzerland" (Festschrift Carl Schröter, 1925; pp. 271–278 as Heft 3, *Veroffentl. Geobotan. Inst. Rübel in Zürich*); "Tundra Vegetation of Central Alaska Directly Under the Arctic Circle" (*Proc. Amer. Philos. Soc.*, Vol. 67, 1928, pp. 215–234). To the *Geographical Review* he contributed "Alpine Fell-Fields of Eastern North America" (Vol. 7, 1919, pp. 233–255) and "The Gardens of the Faeroes, Iceland, and Greenland" (Vol. 14, 1924, pp. 404–415); and he is the author of "Unsolved Problems in Arctic Plant Geography" (Problems of Polar Research, *Amer. Geogr. Soc. Special Publ. No. 7*, 1928, pp. 143–153).

Dr. Harshberger was also actively interested in conservation. He was president of the Botanical Society of Pennsylvania and of the Philadelphia Natural History Society and had served as president of the Ecological Society of America (1926). He was a director of the Geographical Society of Philadelphia.

GEOGRAPHICAL REVIEWS

MONSOON ASIA

JULES SION. **Asie des moussons.** Part I: **Généralités—Chine—Japon.** 272 pp.; maps, diagrs., ills., bibliogrs.; Part II: **Inde—Indochine—Insulinde.** Pp. 273–548; maps, diagrs., ills., bibliogrs., index. (Géographie Universelle, Vol. 9.) Librairie Armand Colin, Paris, 1928. 70 frs. for each part. 11½ x 8 inches.

Professor Sion's book is accurate, up-to-date, and delightfully written. It gives a comprehensive description of southern and southeastern Asia, the home, as the author reminds us, of over half the human race—a region where, throughout the ages, extreme political instability has gone hand-in-hand with an extraordinary stability of culture.

The first three chapters of Part I are general in nature and treat of the geology, climate, vegetation, and modes of life. The mechanism and effects of the monsoons are described; and the author points out one of their essential characteristics which is too often overlooked, viz. the great fluctuations in both summer and winter rainfall from year to year. He also shows that the true rôle of irrigation is not merely that of supplying water where it is lacking, but rather that of equalizing the irregularities of the monsoon rains. In general, the author's viewpoint is that of the futility of geographical determinism alone as an explanation of the types of culture characteristic of monsoon Asia.

The remaining chapters of Part I deal more particularly with China and Japan. The chapter on North China gives an excellent account of the remarkable loess region and the great coal fields of Shansi. It also emphasizes the important fact that the Hwang Ho, or Yellow River, is geologically extremely immature. The chapters that follow deal with the Yangtze basin, with South China, with the economic geography of China as a whole, and finally with the question of population. The importance of agriculture in China is noted, as is the fact that industry and manufacturing are still largely of the household type. Consideration is also given to the place of mining in the national economy. In the author's study of the population he speaks of the high mortality and points out that China in this respect is today where India was before the British occupation.

In regard to the origin of Chinese civilization, the author takes issue with a recent writer on the same subject, Henri Maspero ("Les origines de la civilisation chinoise," *Ann. de Géogr.*, Vol. 35, 1926, pp. 135–154; transl. in *Ann. Rept. Smithsonian Instn. for 1927*, pp. 433–452). Maspero, basing his conclusions largely on a critical study of the written sources, believes that Chinese civilization originated in the Great Plain, along the lower course of the Yellow River. Only much later, he thinks, did it extend westward, into the true loess country. Professor Sion, on the contrary, holds that the movement was from west to east; that, in other words, the archaic Chinese civilization occupied the loess region before it spread over the plain. His belief is amply corroborated by a study of the culture phenomena themselves. For the ancient civilization of China possessed so many of the same fundamental elements upon which were based the great historic cultures of the Near East, that any possibility of a wholly independent origin is precluded. And inasmuch as these features appear, generally speaking, much earlier in western Asia than in China, their diffusion must have been from west to east.

The author then outlines the history of China down to modern times and concludes with a fair summing up of the difficulties facing the new national government.

The last four chapters are devoted to Japan and its dependencies. Their relief and geology are described in some detail, as are the climate and its influence on vegetation. There follows an account of the formation of the Japanese state, with a brief sketch of its development from prehistoric times. The author's suggestion that the rice-culture complex in Japan must have been derived from Korea rather than from southern China, because the Japanese peasant uses the ox instead of the water buffalo, is scarcely convincing. The growing of rice seems to have spread over all these parts of the globe far earlier than did the use of plow animals. The two sets of culture phenomena are quite unrelated. The descriptions of Japanese life as a whole, however, are at once lucid, accurate, and sympathetic.

In the chapter on modern Japan it is pointed out that sixty per cent of the people are still agricultural but that the movement toward the cities, so characteristic of modern life, has already begun. The present-day economic problems of Japan and their solution are also discussed. In the last chapter the colonial empire of Japan, more especially in its economic aspects, is the object of study. An interesting comparison is drawn between the official character of Japanese colonization and that of ancient Greece and Rome, where also governmental action instead of popular initiative was the moving force.

Hokkaido (Yezo), Sakhalin, and the Kuriles are described; and both Korea and Manchuria receive extended notice. The Loochoos, Formosa, and Micronesia are also dealt with in turn. Korea, we are told, is destined to serve mainly as the rice granary of Japan proper. Oil occurs in some quantity in Sakhalin and Formosa, and great coal measures almost everywhere assure an ample supply of fuel for power production. On the other hand, the paucity of iron deposits in the Japanese Empire is a serious lack, bound to react in many ways on the national development. Japan, the author believes, will place less and less dependence, as time goes on, upon imports of raw materials other than iron, cotton, and foodstuffs. Hokkaido will probably in time be colonized on a large scale; but elsewhere the rôle of the Japanese must remain that of the *entrepreneur* and middleman.

The first seven chapters of Part II are devoted to India and Ceylon. Their climate, geology, orography, river systems, vegetation, and economics are described in detail, as are the regional differences and the reciprocating action of the northeast and southwest monsoons. In his discussion of the demography, the author points out the interesting fact that not the Himalayas themselves but the Terai, the marshy and malarious submontane strip of jungle stretching along their southern base, has acted as the ethnic boundary between Aryans and Mongoloids in this part of the world. In Chapter 16 he suggests that the much-discussed "westing" of the rivers in the Punjab may be due to nothing more than ordinary capture. He also notes that the density of population depends not merely on the rainfall but also on considerations of relief and on historical events.

Professor Sion draws a distinction between the character of the British dominion in India and that of modern Japanese colonization. The latter, he quite correctly points out, is fundamentally official; while the former, he tells us, was based on individual initiative. This was no doubt true in great measure; nevertheless the quasi-governmental nature of the old East India Company, with its own armies, fleets, fortifications, and administrative system, should not be forgotten. It is due, says our author, to development of the land routes and the abolition of interior customs barriers that India has developed a true economic unity. In this, as in most other ways, he thinks, British rule has been of vast benefit to that country.

Indo-China is no less adequately dealt with, a very good though necessarily condensed ethnographical and historical sketch of that region being given. Naturally the preponderance of space is devoted to the portions controlled by France, the remainder—Burma, Siam, and the Malay Peninsula—being all included within the limits of a single chapter.

The East Indian Archipelago, "Insulinde," forms the subject of three chapters. Professor Sion's account of the successive strata of population still to be found there is particularly good, as is his appraisal of the civilizing influences exerted by Hindus, Chinese, and Arabs in turn. To American readers the analysis of conditions in the Philippines, by such an independent and thoroughly competent observer, will be of especial interest.

In the concluding chapter is discussed the place of monsoon Asia in the evolution of humanity. The author remarks that it has been its climate above all that has given to this portion of the earth's surface the very real unity which it admittedly possesses. Here, however, he is perhaps running some risk of incurring the very danger against which he cautioned us in the first part, viz., that of overemphasis on geographical determinism. He devotes hardly enough attention to the fact that this part of Asia was overspread, well back in prehistoric times, by a generalized and in many ways strikingly uniform type of Neolithic culture which has afforded the basis for all later development. Hence the contrast he draws between this region and tropical Africa and America, where climatic conditions are similar but where this particular culture was absent, is perhaps not quite to the point.

In the concluding paragraphs are discussed the relations of the various portions of monsoon Asia with one another and with the rest of the world. Finally, Professor Sion treats of the prospects for the future, including the possibility of the rise of an "Asiatic peril." Regarding the latter he displays a considerable but probably not unjustified optimism.

Appended to the various chapters are well selected and up-to-date bibliographies, which, however, do not quite make up for the absence of footnotes giving more specific documentation. There are detailed tables of contents and a good index. The plates are admirably selected, well executed, and truly illustrative in the best sense. There are also statistical tables, maps in the text, and excellent double-page hypsometrical maps of Japan and Korea and of Indochina in colors.

Carl W. Bishop

Tropical Australia

Captain Sir G. H. Wilkins. **Undiscovered Australia: Being an Account of an Expedition to Tropical Australia to Collect Specimens of the Rarer Native Fauna for the British Museum, 1923–1925.** xiii and 353 pp.; map, ills., index. G. P. Putnam's Sons, New York and London, 1929. $4.50. 9 x 6 inches.

"Eyes belong you lookabout, see everything," said the Milingimbi natives of Captain Wilkins, whom they placed in a new category, "proper-white man," for he did not fit in with the "missionary" or "white man" (policemen, traders, surveyors, and stockmen) of their experience. This was while he was engaged in making a collection of the rapidly disappearing native fauna of Australia for the British Museum (Natural History) in the years 1923–1925, an interlude between Antarctic and Arctic exploration. The shrewd native comment is confirmed in the appendix of this volume which, referring to the scientific results, says "seldom has an exploring expedition been managed with such economy and carried out so exactly to plan."

Wilkins collected chiefly in Queensland on both sides of the Great Dividing Range, about the Gulf of Carpentaria, and in the northern part of Northern Territory. Perhaps the most interesting thing in his book, geographically speaking, is the picture he presents of the country from the standpoint of settlement, the more interesting in that this was not his specific purpose and that he views the question impartially. Darwin, a straggling town, in which "we first noticed the meanness which seems to permeate the northern part of Northern Territory"; barren areas of the Cape York peninsula, where the land about the Macmillan River, surveyed by Captain Wilkins, is "veritably a biological desert"; the lean country of the King

River district, whose natives practice "promiscuous cannibalism"; the deserted cattle station of Marumba (on the divide between the Roper and Goyder rivers; not shown on the accompanying and scarcely adequate map), whose holders had "long since given up the struggle with droughts and difficulties of transport." True, there are fertile lands in the north, but the necessary capital and labor are not likely to be attracted while there "still remain districts nearer the existing lines of communication which might develop with less initial expenditure and equally satisfactory results."

Wilkins testifies to the wonderful value of the rolling downs of central Queensland "even in abnormal drought conditions," but he is unfavorably impressed with the social and cultural status of the settlers. In the country they occupy poor makeshift quarters and mediocre dwellings on their retirement to the suburbs of the cities. "One of the most disappointing things to me as an Australian was to find that so many able-bodied men 'retired' from productive work with only just enough money for a bare existence. They form a leisured class without high culture and without the desires or inclinations that foster the development of art or learning." It is hardly surprising: Queensland had only three-quarters of a million population at the 1921 census: Brisbane, the metropolis, had some 210,000 inhabitants, and there were 180,000 more in the provincial towns—a slender thread of urban culture for 670,000 square miles of territory in this remote corner of the world.

A New Zealand National Park

James Cowan. **The Tongariro National Park, New Zealand: Its Topography, Geology, Alpine and Volcanic Features, History and Maori Folk-Lore.** iv and 156 pp.; maps, diagr., ills., index. The Tongariro National Park Board, Wellington, 1927. 8½ x 5½ inches.

The Tongariro National Park is situated in the center of North Island of New Zealand, halfway between Wellington and Auckland, about 150 miles from each. It covers an area of almost 250 square miles, representing, however, only six per cent of the national park area of New Zealand, which totals over two and a half million acres. This is virtually one-third of the area of the national parks in the United States. It is perhaps fair to say that no other country of the world has so great a proportion of its area devoted to national parks and forests as New Zealand has. Not even the United States can boast so great a variety of physiographic and geological features so splendidly preserved in her public playgrounds.

Tongariro lies southwest of Taupo, New Zealand's largest lake. On the center of the prairie plateau that constitutes the park, in a line almost north and south, rest the three lofty mountains Ruapehu, Ngauruhoe, and Tongariro, which form the nucleus of the National Park, a gift to the nation from the paramount chief of the Taupo, Te Heuheu Tukino, forty years ago. These volcanoes, rising to heights of 7500 to 9000 feet, exhibit every range of volcanic phenomena: lava streams, steaming craters, sulphurous pits, boiling lakes, geysers, and fumaroles vie with glaciers and snow fields.

Mr. Cowan's book gives first a readable and easily understood general description of the park, followed by a history of the region and an account of the native legends and folklore. A chapter is devoted to a detailed description of each of the three great peaks, enlivened by reference to the pioneer ascents.

A chapter by Mr. B. C. Aston, President of the New Zealand Institute, describes the plant life, and there is a chapter on Maori place names. The final chapter gives facts concerning routes to the park, facilities for pleasuring, and accommodations for travelers and campers.

The book is excellently illustrated with photographs of the mountains and waterfalls, the various plants, and some of the historic characters; it also includes two large maps showing in detail the configuration of the country. It is obviously designed for all sorts of readers, some of whom may be as much fascinated by early legends as by descriptions of natural phenomena. It has been written by one not unaware of the beauty and the romance of the country he describes.

A. K. LOBECK

AN ATLAS HANDBOOK OF THE ITALIAN COLONIES

MARIO BARATTA AND LUIGI VISINTIN. **Atlante delle colonie italiane con notizie geografiche ed economiche.** xv and 87 pp.; maps, ills., index. Istituto Geografico de Agostini, Novara, 1928. 10½ x 7 inches.

Professors Baratta and Visintin are the authors of the "Grande Atlante Geografico" (Istituto Geografico de Agostini), the first edition of which appeared in 1922 and which has subsequently been published in second (1925) and third (1928) revised editions (see "Post-War Atlases: A Review," by W. L. G. Joerg, in *Geogr. Rev.*, Vol. 13, 1923, pp. 583–598). In this new work the authors have happily applied the concepts of their world atlas to the Italian colonies. The result is a timely and most convenient atlas handbook. The effective physico-political maps of Libya, Eritrea, and Somalia on the scale 1 : 5,000,000 have been reproduced with some revisions from the "Grande Atlante," and there are larger-scale sectional maps of the African possessions and a map of Italy's Aegean Islands on the scale of 1 : 1,000,000. The small-scale political map of Africa is brought up to date (1927) though the new boundary of Kenya Colony west of Lake Rudolf (see Colony and Protectorate of Kenya: Report for 1926, *Ann. Colonial Repts. No. 1352*, London, 1927) is not shown; and, of course, the Italian version of the Libyan-Anglo-Egyptian-Sudan boundary is given. The rainfall map of the "Grande Atlante" is reproduced; the vegetation map is revised.

The maps are preceded by a brief historical introduction and followed by a novel and valuable feature, 60 pages of rotogravure illustrations, including some interesting views of the great irrigation works in southern Somalia (compare Professor Dainelli's paper elsewhere in this *Review*). Then come 43 pages of concise geographical description.

DISCOVERY OF AFRICA IN THE MIDDLE AGES

CHARLES DE LA RONCIÈRE. **La découverte de l'Afrique au moyen âge: Cartographes et explorateurs.** Vol. 1: **L'intérieur du continent,** viii and 175 pp.; maps, ills.; Vol. 2: **Le périple du continent,** 147 pp.; maps, ills.; Vol. 3: **Un explorateur français du Niger,** viii and 130 pp.; maps, index. *Mémoires Soc. Royale de Géogr. d'Égypte*, Vols. 5, 6, and 13. Cairo, 1925–1927. 14 x 11 inches.

In 1402 a French gentleman set out on a long journey into Africa. He went as far as the city of Gago, where he married a rich princess, and returned after eight years to Toulouse with his family and many blacks, amongst them being an eunuch named Aben Ali who was a great physician. According to M. de La Roncière the city of Gago is Gao on the Niger, and the language of the Turkish and African glossaries which the French gentleman, Anselme d'Isalguier, added to the description of his voyages is Tuareg. This information, taken from a contemporary chronicle, affords M. de La Roncière material for a charming "Idylle franco-nègre dans la boucle du Niger (1405–1413)," the opening chapter of his recently published third volume on the discovery of Africa in the Middle Ages.

It is corroborated by the portolano of Mecia de Viladestes of the same year 1413 which shows, for the first time, some true knowledge of Ahaggar and the towns of Tuat, Tamentit, and Buda. The lost manuscripts of Isalguier, when rediscovered, should speak the last word, of course, but other documents may be found to strengthen the theory. It is typical of M. de La Roncière. Those visitors to the Bibliothèque

Nationale who have been favored with a personal visit in his private room have enjoyed the tale of his discoveries in the history of Africa in all their first freshness with a wealth of detail and unexpected suggestions and new historical combinations.

M. de La Roncière's work, new in material and written in vivacious French style by a master of the language, calls for our admiration. It is full of details which, by being put in their rightful place, acquire importance hitherto unrealized. The author, however, has not merely filled a storehouse from his stupendous knowledge of original sources but has used them to help him trace new lines of investigation. Briefly he calls our attention to the general history of geographical discoveries, leading up to the discovery of America by Columbus. This event had its beginning many centuries before Christ, when people realized for the first time that the then known inhabited world was only a fourth part of the globe; the next step was the idea that the other three parts might contain dry land, perhaps even peopled by unknown men for whom names were invented. Those lands and peoples, however, could not be reached. In 1492 they were reached. Between these two points lie twenty centuries. Starting with the discovery of a very unusual fifteenth-century Portuguese portolan chart, in which he saw the hand of Columbus, M. de La Roncière evolved the theory that the discovery of Africa in the Middle Ages was one of the last phases of this long history. The map attributed to Columbus bears no name or date and had never been examined before M. de La Roncière found it. We must give him the right to conceive his theory and see how he proves it. He states in his third volume that the number of adherents to the theory is constantly increasing. Even if one does not agree with the identification of the map, he must admit that the theory has been and will be very fruitful.

In his third volume he gives the full development of his ideas: depreciation of money value through the Hundred Years' War, hence the desire for a gold standard, leading to the search for gold by the Genoese merchants, Columbus being one of their commercial travelers! I hear from M. de La Roncière that they are searching the records of the notaries for the history of the famous house of Centurione.

The work as a whole, so rich in material that it may be called a program for the geographical history of Africa from Greco-Roman times to the end of the Portuguese epoch, will prove the best guide to the reviving study of African history, and thanks are due to H. M. Fuad I, King of Egypt, for his august patronage and the encouragement given to these researches.

The first volume treats of "L'intérieur du continent." In a short, but fully documented, chapter the knowledge we have of the old Roman cartography is surveyed and the influence of the Arabs revealed. The origin of the portolan map (thus named by Nordenskiöld) is ascribed to the Genoese, and its first mention is fixed at 1270, when a map was produced on the sea voyage of St. Louis. As all its derivatives mention Kaffa (=Feodosia), a Genoese colony founded in 1266, it cannot be much earlier. La Roncière hazards a theory in regard to its author and calls attention to the name of Zaccaria, on the Black Sea coast in a thirteenth-century portolan chart. This name may indicate a trading post of the Zaccarias of Genoa.

It was not until the thirteenth century that Cape Blanco was reached by the Arab Ibn Fatima, and the Genoese expedition of the Vivaldi reached Somaliland in 1291 on the way to the mysterious Christian prince Prester John. His name may be derived from the Amharic title Zan or Gan for Majesty, and his first appearance in history is between 1165 and 1177. The Red Sea was visited in 1182 by five French galleys.

On the oldest portolans and portolan charts echoes of these enterprises and explorations are observed, and real value is given to names and pictures which have perhaps been too much considered as phantasies and ornaments.

The chapter devoted to the knowledge of the Sahara in antiquity and in the Middle Ages is of absorbing interest. Few people have realized how much was known of these regions, and the picture La Roncière gives of the caravan routes and of the flourishing cities which are now "villes mortes" is seductive. Here the author comes to one of his special points: "l'ère juive du Sahara" and the connection between the cartographers of Majorca, the Cresques, Mecia de Viladestes, Gabriel de Vallsecha, and their Jewish kinsmen in the Sahara. The famous Catalan atlas of 1375 is attributed to Abraham Cresques.

The Sudan was visited by a European for the first time before 1283, according to the report of Raymond Lull. An Andalusian architect, Tueïdgine, commissioned to build a palace in Timbuktu, died there in 1346. A manuscript discovered by the author revealed the first description of Tuat in 1447 by a European eyewitness, Antonio Malfant. Timbuktu was again visited by the Florentine, Benedetto Dei, in 1470, and by the French navigator, Paul Imbert, in 1618.

This knowledge of interior Africa laid down on the medieval portolan charts was not, however, reproduced by later cartographers and was hence forgotten.

In the second volume the Portuguese circumnavigation is preluded by references to the "Fortunate Isles," which are identified as the Azores and the Canary Islands, visited in 1341 by the Genoese, Niccoloso di Recco, and the Florentine, Angelino del Tegghia. Several visits to the Canary Islands by Spanish and Italian ships are well established by contemporary documents. For the French factories on the coast of Guinea in the fourteenth century, the reference is as late as the book of N. Villault de Bellefond, "Relation des costes d'Afrique appelées Guinée," which appeared in 1669. The archives of Dieppe were burnt in 1694, so this account cannot be verified by original documents. "Ah! l'irritant problème!"

The last chapter of the periplus is of special interest. It relates visits of Europeans to Egypt in the Middle Ages, summarizes what was done during that epoch to discover the sources of the Nile, and gives full information on European ambassadors and artists in Abyssinia. It culminates in the large world map of Fra Mauro in the Doges Palace in Venice. This map has been dated 1457 or 1459. M. de La Roncière found that in 1811, when the map was removed from San Michele de Murano to the Marciana, an inscription at the back revealed that it was completed in 1460.

The work is accompanied by 40 plates, mostly of the African portions of medieval maps very well reproduced and quite readable.

F. C. Wieder

A Chapter in the History of Communications

H. L. Hoskins. **British Routes to India.** xiii and 494 pp.; maps, ills., index. Longmans, Green & Co., New York, London, Toronto, 1928. $7.50. 9½ x 6½ inches.

For over two and a half centuries after the East India Company received its charter in 1600 the main line of communication between Great Britain and India was by sea around the Cape of Good Hope. There were good reasons why the more direct natural routes leading from the eastern Mediterranean through the Red Sea and through Mesopotamia and the Persian Gulf were not used. Each of these routes necessitated a passage by land across difficult desert country where the traveler and his goods were at the mercy of roving Bedouins. Uncharted coral reefs and fickle winds in the Red Sea, the southwest monsoon on the Indian Ocean, and pirates in the Persian Gulf constituted serious dangers to navigation by sail. Furthermore, the Turkish government looked with jealousy and suspicion on Christian intruders. All in all, the hardships of the Cape voyage were insignificant as compared with those of a journey by the direct routes, and the shipment of freight in bulk by the latter was entirely out of the question. As a consequence, before the opening of the last century Great Britain was not particularly concerned with the possibility of developing these routes or with the political situation in the portions of the Near East through which they pass.

Before the middle of the nineteenth century, however, a great change was well under way. The invention of the steamship, the railroad, and the telegraph demonstrated that the establishment of more direct lines of communication was entirely practicable. Turkish prestige was crumbling, and the relatively progressive house of Mehemet Ali was in control of Egypt. The British government had put down piracy in the Persian Gulf, and the coral reefs of the Red Sea were being charted by British hydrographers. De Lesseps was pushing his plans for a canal through the Isthmus of Suez, and the possibility of rail and water transport by way of Syria, the Euphrates, and the Persian Gulf was the subject of serious consideration on the part of the British government. In India the constant increase in the number of British officers and civilians and the enlargement of British administrative responsibility formed additional stimuli to the search for a more rapid and convenient route than that taken by sailing vessels around Africa.

In the scholarly volume under review Dr. Hoskins tells the story of the establishment of steamship and telegraphic communication between Great Britain and India by the routes through the Mediterranean and Near East. In its early stages, particularly before the completion of the Suez Canal, this is a story of slow and halting progress. Innumerable false starts were made, and failure was as frequent as success. Physical obstacles of a type that we now tend to forget had to be overcome. For example, the horrors of the plague which often infested the ports of Egypt and Syria "were unquestionably one of the most potent factors in delaying the actual opening of either of the shorter land passages in conjunction with steam lines." Ocean-going steamers of the twenties, thirties, and forties consumed an inordinate amount of coal for the power developed. Similar difficulties attended the earlier efforts to establish telegraph lines. An attempt was made in 1859 to lay a cable from Suez to Aden as a link in the line from Constantinople to Karachi. In the course of this work it was found that the "surveys made of the floors of the Red and Arabian Seas were very inadequate." As a result, the cable had to be "laid by compass without any attempt to select a bed of uniform depth, and the cable itself was not equally well adapted to various water temperatures and ocean topography. . . . The protective wire wrappings of the line quickly disintegrated in the warm salt water of the Red Sea." This, combined with the destructive work of marine borers, sharks, tidal currents, and sharp rocks all led to the complete failure of the enterprise.

These random examples of physical difficulties illustrate some of the many points of distinctive geographical interest brought out by Dr. Hoskins. Obstacles of this sort, however, have had to be overcome in the creation of every effective system of communication and constituted by no means the most serious difficulties encountered by the promoters of British lines of transportation to and communication with India. The growth of such lines of communication has at all times been conditioned by much larger political issues. One of the most valuable qualities of Dr. Hoskins' book is that the more intimate account of the building up of steamship and telegraph routes is clearly presented against this broader political background.

A Treatise on Czechoslovakia

Fritz Machatschek. **Landeskunde der sudeten- und west-Karpatenländer.** xi and 440 pp.; maps, diagrs., ills., bibliogr., index. (Bibliothek Länderkundlicher Handbücher herausg. von Albrecht Penck.) J. Engelhorn, Stuttgart, 1927. Rm. 30. 9 x 6 inches.

Every geographer who desires a fundamental understanding of Czechoslovakia and critical adjacent territory will wish to acquaint himself with Machatschek's admirable treatise. The author has lived in the region for many years and has first-hand knowledge of every part of it. The reviewer has walked through diverse parts of the region and is impressed with the thoroughness of this presentation. For source material the volume is a mine. A bibliography of 945 titles almost staggers one; yet Machatschek modestly says that, while he has not included all available titles, he hopes that none of the more recent important discussions has been overlooked. Numerous tables, maps, and illustrations illuminate the treatise.

The author divides the book into two parts—the first presenting the territory from the viewpoint of its political composition, and the second according to twelve major natural regions. The second part is the more strictly geographic. The first part frequently includes material of a purely economic or political character but indispensable to a well balanced geographic interpretation.

The volume contains many subjects that invite discussion. A few points only may be touched upon here. The elongate character of Czechoslovakia is pointed out as unfavorable to the effective development of the country as a unit, although it serves well as a connecting link between highly developed, densely populated central Europe and the industrial, raw-material region of the Poles, Magyars, and Rumanians. It assumes a bridgelike character between advanced western Europe and backward eastern Europe.

An unexpected conflict between national well being and the sudden acquisition of a surplus in natural resources is strikingly illustrated. As a part of Austria-Hungary, this region produced three-quarters of the coal, three-fifths of the iron ore, and an average of four-fifths of the manufactures. With the establishment of the republic immediate prosperity did not arise, for the purchasing power of vast numbers of persons was curtailed in all the contiguous territory, which had now become foreign in relation to Czechoslovakia. The latter's relative gain in resources was offset by the former's loss and consequent decline in wealth. Furthermore, new tariff walls restricted exports. While the effect upon Czechoslovakia was temporary, it at first was somewhat of a shock which the people had not anticipated.

Professor Machatschek shows here and there some bias in favor of the German element. His use of the German form of geographic names, when they are no longer official in Czech circles, is open to question. Shall we insist that the capital be called *Prag* when its citizens have decided upon *Praha*, a word no more difficult to spell or pronounce?

The Czech-German language fight and the historical background of present political, social, and religious settings are all effectively presented. These humanistic aspects are preceded by a discussion of the physical environments in which they have been evolved.

Eugene Van Cleef

Niagara Falls and Gorges

W. H. Boyd. **A New Method of Determining the Rate of Recession of Niagara Falls.** Diagrs., ills. *Trans. Royal Soc. of Canada*, Vol. 22, 1928, Sect. 4, pp. 1–12.

W. A. Johnston. **The Age of the Upper Great Gorge of Niagara River.** Map, diagrs. *Ibid.*, pp. 13–29.

The Falls of Niagara were surveyed in 1841–1842, 1875, 1886, 1890, 1904–1905, 1905, 1906, 1911, 1917, and 1925. In 1927 they were mapped for the eleventh time by Boyd after a phototopographical method. Surveying camera pictures were taken simultaneously from three stations of the same portion of the falls, so that identification of points—the difficulty encountered in previous surveys—became an easy matter. The mean annual rate of recession of the Horseshoe Fall from 1842 to 1905 is found to be 3.8 feet and from 1905 to 1925 2.3 feet. The retreat of the American Fall was calculated by G. K. Gilbert at 0.2 foot per annum; but the fall has apparently undergone no recession since 1895.

Johnston's paper deals with two separate problems, viz. the age of the Upper Great Gorge of Niagara and the time of formation of the Whirlpool Rapids Gorge. Formation of the Upper Great Gorge, which is now 2¼ miles long, began when the Upper Great Lakes for the last time started to drain through Lake Erie and the Niagara River. Boyd's new figure of 3.8 feet as the mean rate of recession of the Horseshoe Fall, instead of Gilbert's figure of 5 feet, makes it probable that the cutting of the gorge represents some 4000 years, instead of 3000 to 3500 years as held by F. B. Taylor.

In 1899 two borings and in 1919 17 borings were carried out by the Michigan Central Railroad Co. at the upper of the two railroad bridges across the Whirpool Rapids near the lower end of the Upper Great Gorge. They show that there is a filling of unconsolidated materials to a depth of about 100 feet below the present bed of the river. On the logs of the borings this material has been divided by Johnston into talus and glacial drift—and there is little doubt that it really is glacial drift. The presence of drift in the bottom of the gorge shows that the whole of the Whirlpool Rapids Gorge, including the Whirlpool, is an old gorge filled with glacial drift and reëxcavated in part by the postglacial Niagara River. This view is radically different from the old one that the gorge was formed by recession of the falls in postglacial time during the Nipissing Great Lakes stage, when the Upper Great Lakes were drained through the Mattawa-Ottawa valleys. During the last-mentioned stage only reëxcavation of the gorge, which seems to have been accomplished by a much smaller stream than the present one, may have taken place.

The drift-filled Whirlpool Rapids Gorge may have been already cleaned out to some extent when the lower late-glacial gorges were formed. When the Lower Great Gorge had extended up to the Whirlpool, a fall eventually began to form at the upper end of the interglacial Whirlpool Rapids Gorge. But this again would mean that the Upper Great Gorge would have started forming at the beginning of or in the early part of the Nipissing Great Lakes stage and that there would be no difference in width between the Nipissing Great Lakes gorge and the gorge formed after modern conditions were established.

The Whirlpool, as is well known, forms the upper part of an interglacial drift-filled channel, the St. David Gorge, extending northwestward to Lake Ontario. The much greater depth of the Whirlpool and the Eddy Basin, the expansion just above the Whirlpool, than of the Whirlpool Rapids may mean a considerable change of level in relation to Lake Ontario. The change in width of the canyon at the same place may mean a change in the volume of the water. The St. David Gorge and the Rapids Gorge date perhaps from different interglacials.

While the Upper Great Gorge may represent about 4000 years, "the age of the Niagara Gorge as a whole cannot be determined, for there is no way of telling the rate of formation of the Whirlpool Rapids Gorge nor of the lower gorge reaching from the Whirlpool to the escarpment at Queenston."

Ernst Antevs

History of the Mounted Police of Canada

T. Morris Longstreth. **The Silent Force: Scenes from the Life of the Mounted Police of Canada.** xiv and 383 pp.; maps, ills., index. The Century Co., New York, 1927. $4.00. 9 x 6 inches.

Mr. Longstreth's history of this famous police force, is written, it must be confessed, in something of its spirit, although adherence to actual events necessarily curbs any fantastic flights. For a knowledge of these events he was able to draw on the records of the police headquarters; for their interpretation he consulted its officers, lived at some of its barracks, and traveled from one end of Canada to the other.

He traces the history of the force from its birth in 1873, explaining clearly how what was in earlier days a semi-military organization designed to keep peace on the prairies gradually developed into a super-police and detective force operating in all parts of the Dominion. No attempt is made to place this development in its proper setting, to outline the spread of settlement west and north, the rapid growth of the various provinces, and the tremendous increase in population, production, and trade. Instead, the book assumes the character of a regimental history. In spite of its brief career, however, the "Force" has gained a record of which every Canadian is justly proud, and Mr. Longstreth has done a real service in setting forth that record for the inspection of all the English-speaking world. If he waxes a little overeloquent in places, as when he describes the Winnipeg riot of 1919, we feel inclined to condone it because no one can steep himself, as he has done, in the records of the Mounties without becoming an enthusiastic partisan. His book recalls or rescues from oblivion many stirring deeds, some of which, like the guarding of the Chilkoot Pass during the Yukon gold rush, deserve to find a place in every Canadian history. But on the whole its appeal is to the general public and to historians, rather than to geographers. One may draw attention, perhaps, to some of the northern patrols undertaken during the last few years—Inspector French's journey, for example, from Baker Lake to Bathurst Inlet on the Arctic coast, and Sergeant Wight's trip across the south of Baffin Island. There is new and interesting geographical information in the published accounts of both these journeys. And one may regret in closing that the author could not record the most remarkable patrol of all, Sergeant Joy's exploration of Ellesmere Island and other parts of the far northern archipelago in the winter of 1926–1927.

D. Jenness

North and East Greenland

Lauge Koch. **Nord om Grønland.** 279 pp.; map, ills. Levin & Munksgaard, Copenhagen, 1927. 10 x 7 inches. French translation, "Au nord du Groenland," by Margrethe Trock.

Knud Rasmussen. **Report of the II. Thule-Expedition for the Exploration of Greenland from Melville Bay to De Long Fjord, 1916–1918.** Maps, ills. *Meddelelser om Grønland*, Vol. 65, 1928, pp. 1–180.

Lauge Koch. **Contributions to the Glaciology of North Greenland.** Maps, diagrs., ills., bibliogr., index. *Meddelelser om Grønland*, Vol. 65, 1928, pp. 181–464.

Lauge Koch. **Two Recent Journeys on the Coast of Eastern Greenland.** Map, ills. *Geogr. Journ.*, Vol. 71, 1928, pp. 1–15 (discussion, pp. 13–15).

Gunnar Isachsen. **Grønland og Grønlandsisen.** 248 pp.; maps, ills., index. J. W. Cappelen, Oslo, 1925. 9 x 6½ inches.

Lauge Koch first visited Greenland in 1913; he took part in Knud Rasmussen's expedition of 1916–1918; and in 1920 he started on his own expedition to North Greenland. After spending the winter on Inglefield Gulf (77½° N., 71° W.) at the northwestern corner of Greenland he set out on a journey that took him and his Eskimos over the frozen fiords and glaciers around the north coast of Greenland, down the east coast of Peary Land, and over the northern part of the land ice back to the starting point, which was reached at the end of September. After wintering at Tasiusak and Upernivik in 1922 he undertook journeys to the 82nd parallel and to Humboldt Glacier for geological studies. After another winter in Upernivik, in the spring of 1923 he mapped the Cape York District.

"Nord om Grønland" is a colorful description of events, of storms, of hard travel over pack ice and crevassed glaciers and through icy water, of hunger and fantastic hunger dreams, of subsistence for weeks on the meat of starved dogs and loss of dogs by starvation and exhaustion, of wild joy and feasts when the hunt had been successful.

Volume 64 of the *Meddelelser om Grønland*, published in 1927, contained thirteen papers presenting some of the scientific results—cartographical, hydrographical, biological—of the Second Thule Expedition, 1916–1918. In the first part of Volume 65 we have the general account of the journey by the leader, Knud Rasmussen (compare *Geogr. Rev.*, Vol. 8, 1919, pp. 116–125, 180–187). In the second part Lauge Koch discusses the glaciology of North Greenland on the basis of the data collected during the Second Thule Expedition and during his later journeys in the region (see above). Some observations made on his expedition to East Greenland in 1926–1927 (see below) have also been utilized.

Precipitation, which is almost exclusively in the form of snow, amounts to less than 100 millimeters. In consequence there are extensive ice-free areas along the coasts, and the snow line lies at the remarkable altitude of from 500 to 1250 meters. The summer temperature is comparatively high. Comparisons are made with the glaciers and inland ice of the Antarctic.

With the exception of glacier ice formed on the sea, all the types of glaciers defined by R. E. Priestley in the Antarctic are represented in North Greenland, though they are generally not well developed.

The land ice in North Greenland rests on a low and rugged rock surface by which its contour is markedly affected. It does not reach the sea except through glaciers ending in the fiords. The edge of the ice sheet has been stationary at any rate during the last hundred years and probably for several hundred years. On the other hand some of the glaciers undergo oscillations.

During the ice age the whole of North Greenland, with the exception of the northern half of Peary Land, Northumberland Island (?), and several steep nunataks, was covered by the ice sheet.

In the postglacial age the shore line on the north coast for a time stood as much as 210 meters higher than today. With a single exception none of the glaciers whose front now lies near the 210-meter level has been farther advanced since the maximum of the subsidence.

In 1926 the Danish government financed Lauge Koch's expedition to the east coast of Greenland with the Eskimo colony on Scoresby Sound as its base. The prime object was a geological survey of the coast. In addition an economic survey was undertaken, and the expedition fulfilled a requirement of the treaty of 1923 between Denmark and Norway by visiting the hunting stations of the East Greenland Company, for "if the houses are not officially surveyed every five years the possession would be lost—this particular part being 'No Man's Land.'" Two long sledge journeys were made, one in November to Hold with Hope (latitude 74° N.), the other in the spring of 1927 to Denmark Harbor (latitude 76° 40′ N.).

Major Isachsen's book deals largely with experiences in the ice on the east coast of Greenland in 1923 and 1924. Told in diary form it gives a graphic idea of conditions in that difficult area.

In 1923 the *Conrad Holmboe* sailed to relieve the observers at the Norwegian radio station of Myggbukta, a little north of Franz Josef Fjord. The ship was caught in the ice and drifted for about two months. She eventually got away and went down to Iceland, almost a wreck. Another ship, the *Polarulv*, sent out to rescue the *Holmboe*, was wrecked in the ice with the loss of four men. The same summer two other ships, the *Anni* and the *Teddy* were lost in the ice off East Greenland. When nothing was heard from them in the spring of 1924 a rescue expedition was sent out and found the crew of the *Teddy:* the *Anni* and her crew were never found.

In the last chapter the author criticizes the agreement between Denmark and Norway concerning the right to hunt and fish on the east coast of Greenland. Texts relative to the agreement are given in the appendix.

Ernst Antevs

Air Pioneering in the Arctic

Air Pioneering in the Arctic: The Two Polar Flights of Roald Amundsen and Lincoln Ellsworth. 126 pp.; maps, ills. National Americana Society, New York, 1929. $35.00. 14 x 11 inches.

"From first to last the history of Polar exploration is a single, mighty manifestation of the power of the Unknown over the mind of man." If illustration of Dr. Nansen's often-quoted words be wanted it may be found in "Air Pioneering in the Arctic" with its photographs so exquisitely reproduced, with such skillfully caught "atmosphere," that it is impossible not to be profoundly affected by them. Look, for instance, at No. 12, Part I, the N 25 "like a gnat in an ocean of space just before landing 600 miles into the unknown"; or No. 13, "a forced landing 136 miles from the north pole"; or No. 22, Part II, "first human vision of the 'great unknown' lying between the north pole and Alaska." And who could fail of response to the sight of the "first land after 2000 miles—the coast of Alaska" (No. 25)?

In "Air Pioneering in the Arctic" Mr. Ellsworth has brought together material from various sources—including selected portions of "Our Polar Flight" and "The First Crossing of the Polar Sea"—to tell vividly the adventures into the unknown that he shared with Amundsen in 1925 and 1926. Appropriately the volume concludes with his deeply-felt tribute to the lost comrade, the "supreme adventurer." On the geographical aspects of the pioneer flights of 1925 and 1926 reference has been made in the *Geographical Review* (see Vol. 15, 1925, pp. 665–667 and Vol. 16, 1926, pp. 662–665); here it suffices to repeat that they were doubly penetrations of the unknown—in space and technique.

On the Polar Regions

R. N. Rudmose Brown. **The Polar Regions: A Physical and Economic Geography of the Arctic and Antarctic.** ix and 245 pp.; maps, bibliogr., index. Methuen & Co., Ltd., London, 1927. 12s. 6d. 9 x 6 inches.

A. W. Greely. **The Polar Regions in the Twentieth Century: Their Discovery and Industrial Evolution.** x and 270 pp.; maps, ills., index. Little, Brown & Co., Boston, 1928. $4.00. 9 x 6 inches.

J. Gordon Hayes. **Antarctica: A Treatise on the Southern Continent.** xv and 448 pp.; maps, diagrs., ills., bibliogr., index. The Richards Press, Ltd., London, 1928. 42s. 10½ x 7½ inches.

The recent progress of polar exploration and our changing attitude towards the polar regions is well illustrated by these three books. Dr. Rudmose Brown states in his preface that his study "is not confined to physical and biological geography, but deals at some length with the growing commercial and political penetration of polar regions and the colonization of land in high latitudes," and General Greely that his aim is to show the "increased utilization of the material resources of the polar regions."

Dr. Rudmose Brown's book appears in Methuen's Geographical Series, which already had to its credit excellent volumes on North America (by L. Rodwell Jones and P. W. Bryan) and South America (by E. W. Shanahan), and maintains the high standard set. Its author is eminently qualified for the task. He has had personal experience in both Arctic and Antarctic; he has written extensively on many phases of these regions; he is a teacher of many years' standing. His book is well balanced as well as authoritative; and, more, possesses that supreme virtue of a textbook of being concise without sacrifice of clearness and accuracy. The arrangement follows the usual convention. The titles of the chapters dealing specifically with the human elements are: The Eskimo; Whaling: North and South; Political Geography;

Trade Routes; Colonization (Greenland and Novaya Zemlya, Spitsbergen, the Canadian Archipelago); Hygiene. One small grievance: in the bibliographical appendix it is said there is "no attempt at completeness" but it is a little annoying to find in the text a reference to the interesting work of C. H. Pollog (p. 40) without a clue to the source (Untersuchung von jährlichen Temperaturkurven zur Charakteristik und Definition des Polarklimas, *Mitt. Geogr. Gesell. in München*, Vol. 17, 1924, pp. 165–253).

General Greely's "Handbook of Polar Discoveries" (5th edit., 1910) has long been a standard work. In "The Polar Regions in the Twentieth Century" he has condensed that history and brought it up to date as the basis of an account of the occupation and utilization of these regions. The Arctic naturally has the lion's share: but the 40 pages allotted to the Antarctic might well have been expanded to give a more adequate idea of the whaling industry here dismissed in a few words. Where condensation is so great it is not surprising to find errors of implication if not of actual fact, for example, the partial statement of conjectures as to the fate of the early Norse settlements in Greenland (p. 94) and the somewhat misleading remark on the Eskimo settlements on the east coast (p. 103), of which until the foundation of the Scoresby Sound colony in 1925 Angmagssalik had for a long time past been the only survivor. The scientific work of Norwegians in Spitsbergen, as Dr. Adolf Hoel protests, is not acknowledged, and there are not a few errors of proof reading, for example, the longitude of Jan Mayen, p. 105; the date of the "Times Book of Russia," p. 164. But General Greely has brought together a suggestive array of facts on the exploitation of the lands beyond the Arctic Circle.

Mr. Hayes's "Antarctica" is a rather curious book. Its purpose is to treat of Antarctica "as fully as possible" . . . "to treat the subject somewhat scientifically, without undue technicality, the standpoint being that of an ordinary educated reader rather than that of a specialist." The author has had no experience in the regions he discusses, and his study is confined for the most part to such narratives of Antarctic expeditions as are available in English. Withal he has produced a work of real value; within the limitations described he has gone deeply into the subject, and he shows good judgment in the selection and analysis of material. Moreover his book is readable. For a critical analysis of its merits and defects reference should be made to Dr. H. R. Mill's discussion in the *Geographical Journal* (Vol. 72, 1928, pp. 63–66). One feature of the book needs emphasis—the quite exceptionally full index. The index, indeed, makes the book an indispensable tool to the serious student as well as the "ordinary educated reader."

A METEOROLOGICAL TREATISE

W. J. HUMPHREYS. **Physics of the Air.** 2nd edit., revised and enlarged. xii and 654 pp.; diagrs., ills., index. McGraw-Hill Book Co., Inc., New York, 1929. $6.00. 9 x 6 inches.

The first edition of this indispensable book appeared nine years ago (see review by Alexander McAdie in *Geogr. Rev.*, Vol. 11, 1921, pp. 157–159). Much has happened to meteorology since then, and nobody has taken a more active part in bringing about its transformations than the author of the work under review. The second edition contains not only one entirely new section—on Atmospheric Acoustics—but also a great amount of new material scattered throughout. Its text is actually more than twenty per cent longer than that of its predecessor, despite a reduction in both the size and the number of the pages. Smaller type has been used, and the proportion of white paper to printed matter has been diminished to the verge of parsimony.

Dr. Humphreys, as most meteorologists and physicists are aware, is a shining example of the scientific expositor whose motto is that of the Royal Society of

London—*nullius in verba.* He takes nobody's word for anything. The statements found in "Physics of the Air" are there, not because they have appeared in previous books on meteorology, but because each and every one of them has passed the test of a critical review by the author. By the same token, much familiar misinformation that had been passed on from one meteorological writer to another for years or generations is conspicuously absent from Humphreys' treatise.

Within the limits indicated by its title the book is complete and self-contained. Much subsidiary information is made accessible by copious references, but the essential facts are here. The explanations are fully checked by calculations and mathematical reasoning, but this fact does not militate against the use of the book by non-mathematical students and readers. It would, for example, be quite feasible for high school teachers to use selected portions of this work as the basis of an elementary course in meteorology; and until Dr. Humphreys gives us a long-awaited introductory textbook on the subject no other work can be so highly recommended for this purpose.

C. F. Talman

An Attack upon the Gully

J. Russell Smith. **Tree Crops: A Permanent Agriculture.** xii and 333 pp.; maps, diagrs., ills., bibliogr., index. Harcourt, Brace & Co., New York, 1929. $4.00. 9 x 6 inches.

Professor Smith has for many years been the apostle of tree agriculture both by word and by deed. He has written many articles on the subject, among which may be recalled that exceptionally interesting paper "The Oak Tree and Man's Environment" in Volume I (1916) of the *Geographical Review.* In the present work he brings together the results of his own experiences and travels—in the Mediterranean and the Far East in particular—a large correspondence, and much study. Here is the problem. Over large areas in New England and the Appalachians "the hills are gullied. The fields are barren. Tenantless houses, dilapidated cabins, tumbledown barns, poor roads, poor schools, and churches without a pastor—all are to be found in too many places." Professor Smith has a vision of these desolate hills become a green and pleasant and profitable land. His book is "primarily an attack upon the gully." Where land is too steep or rocky or arid for continuous successful cultivation of annual crops, that cultivation should be replaced by a permanent tree agriculture.

The major part of the volume presents "some facts about some crop trees," principally on their value in providing stock foods. It embraces the *keawe* or Hawaiian algaroba, carob, honey locust, mesquites, mulberry, persimmon, chestnut, oak, walnuts, hickories, and there is a "peep at the tropics." There follow sections on farm management and an appendix with a good deal of practical advice. Shift from the grain type of agriculture to the crop-tree type would ideally be approached through an institute or institutes of mountain agriculture, where expert selection could be made of trees, native and foreign, and studies of breeding, soil erosion, etc. carried on. Meanwhile here is an inspiration for the individual farmer who can begin gradually to transform his practice; for Professor Smith is no revolutionist but the advocate of a sober and considered policy.

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p. 33, last line of third paragraph of Appendix: *for* III *read* II.
p. 59, line 21: *for* Frank *read* Grant.
p. 79, insert map: *for* 1000 feet *read* 4000 feet.
p. 81, line 3 of footnote: *for* 1730 *read* 1728.
p. 94, line 1 of footnote 2: *for* Schantz *read* Shantz.
p. 122, line 2 of footnote 4: *for* Humphreys *read* Humphrey.
p. 122, line 3 of footnote 4: *for* 16 *read* 14.
p. 141, line 1 of footnote 11: *for* Marr *read* Maar.
p. 142, footnote 17: *for* 1908 *read* 1918.
p. 144, line 2: *for* Ordinance *read* Ordnance.
p. 157, line 11: *for* I. W. Frantzen *read* W. Frantzen.
p. 159, line 3: *for* Sanford *read* Sandford.
p. 232, line 7: *for* Colomba *read* Coloma.
p. 237, line 2 from bottom: *for* Ayopayo *read* Ayopaya.
p. 251, Figure 1, legend: for the classification of regions credit should be given to Clarence F. Jones: Agricultural Regions of South America, *Econ. Geogr.*, Vol. 4, 1928, map facing p. 1.
p. 319, line 5 of second paragraph: *for* 15 *read* 20.
p. 491, last line: delete period.
p. 623, line 8: *for* Pardaos *read* Pardoas.
p. 674, line 13: *for* cause *read* caused.

ADDITIONAL ERRATUM IN VOLUME XVIII

p. 716, column 1, line 34: *for* Schwiezer *read* Schweizer.

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Professor Johnson is professor of physiography in Columbia University. In addition to numerous physiographic papers, he has written "Shore Processes and Shoreline Development" (1919) and "The New England-Acadian Shoreline" (1925). He has made a special study of the influence of physiography in the conduct of military operations. His "Battlefields of the World War" (1921) is No. 3 of the *American Geographical Society's Research Series.*

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THE
GEOGRAPHICAL REVIEW

VOL. XIX OCTOBER, 1929 No. 4

THE REPOPULATION OF THE ROMAN CAMPAGNA

Roberto Almagià
University of Rome

THE strange fascination of the Roman Campagna has been celebrated by writers of all countries and has inspired many an artist and poet. While other European capitals are surrounded by gardens and fields in the midst of which rise suburbs, villages, hamlets, and country houses, Rome stands in the midst of a wilderness. Whoever climbs to the top of the Torre del Campidoglio or to the dome of St. Peter's or, better still, to the summit of Monte Mario sees spread before him, beyond a very narrow belt of vineyards, orchards, and parks, a vast plain "beautiful in its amplitude of line and its air of desolation."[1] This region, the Roman Campagna or Agro Romano, is limited on the west by the Tyrrhenian Sea, on the north by the Sabatine Hills which enclose Lake Bracciano, on the east by the Sabine and Praenestine Mountains, and on the south by the Alban Hills. The Campagna, the area of which is a little over 2000 square kilometers, lies almost entirely within the Commune of Rome. It is traversed by the Tiber, whose lower course winds across a fairly broad flood plain. A little above Rome the Tiber is joined on the left by the Aniene. Considerably farther down the Arrone, or outlet of Lake Bracciano, joins it on the right, and there are many lesser tributaries usually called *fossi*. A little below the confluence with the Arrone the valley opens out and the delta region begins.

The Campagna for the most part is covered by eruptive materials from the Sabatine Hills to the north and the Alban Hills to the south, volcanoes that have been extinct since the Quaternary epoch. The

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[1] One of the best accounts of the Campagna available in English is a translation of René Bazin's "The Italians of Today" (New York, 1908).

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lavas originating from the Alban Hills form long flows that reach to within a few kilometers of the gates of Rome and, on the north, to the Aniene. Much more widespread, however, are the tufas. Although in some places soft and easily eroded, the latter are frequently hard, compact, and lithoidal. Where this is the case the ground is covered with a resistant crust—the so-called *cappellaccio*—which is extremely difficult to break up. North of the Tiber above Rome blue clays (Pliocene) make their appearance in many localities under the volcanic deposits. The coastal zone, on the other hand, is covered with recent alluvium. Along the seashore there extend lines of dunes, or *tumoleti*, some now in the process of formation, others five kilometers back from the actual coast.

When viewed from one of the high points mentioned the Campagna seems like a monotonous, almost level, or slightly undulating plain. To anyone who crosses it on foot or horseback, however, it presents quite a different appearance, as it is traversed by a very large number of streams which have eroded a myriad of little ravines, *fossi*, in the unconsolidated tufas that constitute the greater part of the terrain.[2] Where a group of lesser *fossi* unites with a larger watercourse to form a finely meshed drainage pattern, the surface is dissected into detached hills—as for instance the famous Seven Hills of Rome.[3] As there are many *fossi*, springs, likewise, are not rare, and there are—or were in the past—numerous tracts covered with stagnant water or with pools, out of which grows a thick swampy vegetation; only near the sea, however, are marshes very extensive. There is a plentiful circulation of subterranean water, coming partly from the Alban and Sabatine Hills and partly from the more distant calcareous Apennines.

This territory, up to a few years ago, was practically a desert, dotted here and there with a few lonely hamlets and abandoned almost entirely to pasture, over which wandered many a herd of cattle and flock of sheep. The imposing ruins of aqueducts, villas, and tombs scattered over its surface gave to the Campagna a mysterious grandeur and desolation, which, combined with its absolute silence, exerted over the mind of every stranger an irresistible charm.

During the last few years, however, this state of affairs has been changing; a tremendous transformation is taking place with ever accelerating pace. The Campagna is being repopulated and restored to cultivation, the desert areas are constantly growing less extensive, and, if the process continues, in the course of a few decades, perhaps, the solemn desolation and profound silence will be only a distant memory. This transformation is of great interest to geographers not only because it is taking place in a region of unique historical importance but also because of the manner in which it is progressing.

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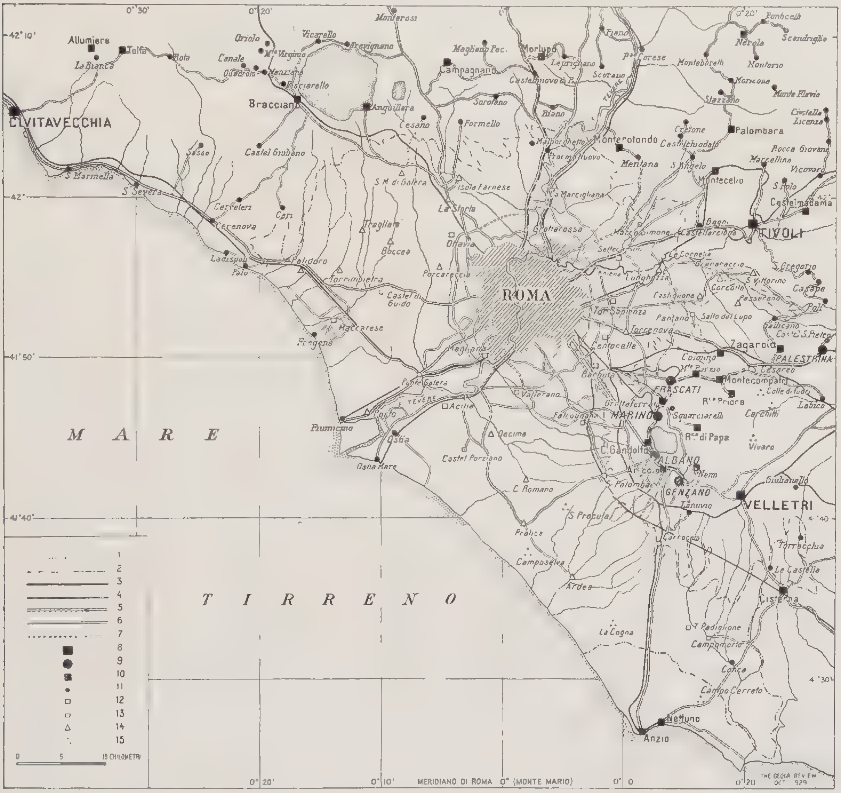
[2] Much has been written on the geology of the Roman Campagna. In "Monografia della città di Roma e della Campagna Romana" (2 vols., Rome, 1878) the geology was studied by P. Mantovani. A geological map on the scale of 1 : 100,000 accompanies this work. Later studies are those of G. Ponzi, R. Meli, G. Clerici, G. De Angelis d'Ossat, V. Sabatini, etc. See also the excellent essay on the Roman Campagna in Sir Archibald Geikie's "Landscape in History and Other Essays," London, 1905.

[3] W. M. Davis: The Seven Hills of Rome, *Journ. of Geogr.*, Vol. 9, 1910–1911, pp. 197–202 and 230–233.



P Rapisardi dis.

FIG. 1—Map of the Agro Romano and adjacent regions (1928). Numbers have reference: 1, boundary of city of Rome and suburbs; 2, boundary of commune of Rome; 3, railways; 4, tramways; 5, chief roads before reclamation; 6, chief roads built subsequently; 7, roads under construction; 8–11, population centers of varying degrees of importance (outside of the Agro Romano only the principal centers are indicated); 12, *borgate rurali* (see p. 548); 13, chief new agricultural centers; 14, principal *casali* (see p. 536); 15, hut villages. Scale of map approximately 1 : 850,000.

The Campagna in Early Days

The Roman Campagna was intensively cultivated at a very remote period, certainly long before the development of the Roman power. One of the most singular and at the same time most convincing proofs of this is to be found in that complicated system of tunnels, or *cuniculi*, which extend out in every direction beneath the surface on both sides of the Tiber as well as beneath the city of Rome itself and reach even as far as the northern flanks of the Alban Hills. These tunnels are generally about a meter, although in some cases two meters, wide, frequently arranged in several series one above the other, and come together in wells now for the most part obstructed or entirely choked up. Whether, as many scholars think (including such archeologists as Ashby and Lanciani), they served for the draining off of the waters from the impermeable areas, where they are most numerous, or whether they served to collect and conserve drinking water for men and beasts and water for irrigation during the long dry summers, according to a recent and not improbable hypothesis,[4] the *cuniculi* prove that the Campagna was the scene of laborious and persevering activity at a very early date. In the early days of Rome there were many inhabited centers scattered over the region. Dionysius of Halicarnassus gives a list of 30 communities, or *populi*, forming part of the so-called Latin Federation, and there is an even older list in Pliny. With the help of these lists and from other sources we may reconstruct a series of some ten small cities, part of them south of the Tiber in Latium Vetus and others north of the river in what was then southern Etruria. One by one these towns fell before the growing power of the Romans and were destroyed, in some cases so utterly and at such an early epoch that it has not been possible to identify even their sites.[5] The conquered territory was divided by tribes, and the Latin Federation definitely broken up in 332 B. C. Some of the cities, however, remained as allies of Rome and, as such, enjoyed somewhat later periods of prosperity.

We know very little of the earliest network of roads in the Roman Campagna. At the end of the fourth century before Christ the construction of the great Roman roads began, a monumental undertaking which was carried on into the following centuries; but these great roads were built to facilitate communication between Rome and the more distant regions of the peninsula rather than to serve the immediate environs; they radiated from the city, with the lesser roads, stretching out like the spokes of a wheel. On the other hand, transverse highways were either entirely lacking or else were few in number. The characteristic divergence of the highways leading across the Campagna has been preserved down to the most recent times, even to within the last few decades, and has exerted a marked influence on the location and distribution of the center of population.[6]

In the most ancient times—before the sixth or fifth century before

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[4] This hypothesis is explained in a penetrating discussion by Plinio Fraccaro: Di alcuni antichissimi lavori idraulici di Roma e della Campagna, *Boll. Reale Soc. Geogr. Italiana*, Ser. 5, Vol. 8, 1 19, pp. 186–215. Here the most important contributions on the subject are cited.

[5] Ameziola, Caenina, Cameria, Crustumerium, Collatia, Ficulea, Longula, Fortinea, Polusca, etc. Even in his time Pliny exclaimed, not without awe, "Ex antiquo Latio tres et quinquaginta populi interiere *sine vestigiis!*" (*Hist. Nat.*, III, 5 (9), 70).

[6] This characteristic of the network of roads is well shown on the map accompanying the recent work of Thomas Ashby: The Roman Campagna in Classical Times (London, 1927), on which are also indicated, so far as known, the routes of the secondary roads (*viae vicinales, diverticula*).

Christ—malaria, later to become a terrible scourge in the Campagna, had either not yet appeared, as Jones thinks, or else afflicted few people and, according to Celli, was of a mild type. Many writers regard this disease as the principal cause for the subsequent depopulation and the consequent decadence of the country. On malaria and its vicissitudes in the course of historical times a great deal has been written;[7] but, even though the propagating agent—the Anopheles mosquito—has been discovered, there are still many problems relating to malaria yet to be solved. According to Celli, this disease, like many others of an epidemic character, would seem to undergo alternate periods of virulence and attenuation, the result of biological factors inherent in the life and development of the propagating agent itself. During the period from about the fifth to the third century before Christ malaria appears to have presented a virulent phase, followed by a long period of attenuation from about the second century before Christ to about the third century of our era. Certainly not before the second century before our era did the habit of constructing villas and sojourning in the country in the neighborhood of Rome begin to become popular among wealthy Romans. This custom spread rapidly with the increase in prosperity and luxury during the last century of the republic and particularly under Augustus, who carried out great operations for regulating the Tiber both above and below Rome. The height of prosperity was, perhaps, reached here as in other parts of Italy under Trajan, Hadrian, and the Antonines. At that time no part of the Campagna was unoccupied by villas, parks, gardens, and cultivated tracts belonging to wealthy Romans. The drainage and irrigation of these estates must have been carefully controlled. However, there were not many centers of population in the Campagna itself even during this period of prosperity. Most of the well known earlier cities had been completely destroyed, and their ruins prompted writers and poets to point out, often in exaggerated terms, this sad decline as compared with the past glory of such places as Gabii, Fidenae, and Bovillae.

Decline of the Campagna

From the epoch of the Severi decadence set in, at first slowly but later spreading with ever increasing rapidity. Political struggles with the consequent abandonment of hydraulic systems, and later the barbarian invasions with a possible recrudescence of malaria, led to the abandonment of the Campagna for the greater part of the entire medieval period.[8] It should be pointed out, however, that, contrary to the usual opinion, the Middle Ages did not represent the most desolate period in the history of the Roman Campagna. The investigations of Tomassetti[9] and others have shown that—at least from the point of view of depopulation owing to malaria—conditions were at the very worst in the seventeenth and eighteenth centuries.

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[7] See W. H. S. Jones: Malaria: A Neglected Factor in the History of Greece and Rome, London, 1907. The most important work on this subject is a posthumous monograph by Angelo Celli: Storia della malaria nell' Agro Romano, *Atti Reale Accademia dei Lincei, Memorie Cl. di Sci. Fis.*, Ser. 6, Vol. 1, fasc. 3, 1925, with illustrations and maps; of great interest on account of the documents brought together on changes in the population of the Campagna from the earliest times to our own day.

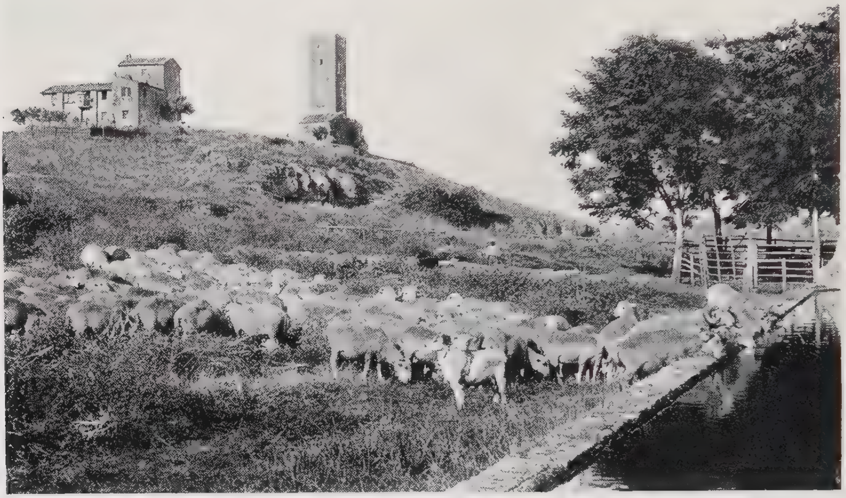

FIG. 2—The *casale* of Pratolungo with its fountain.

Attempts to repopulate the region were not lacking. After the most turbulent period of the barbarian invasions had ended in the eighth and ninth centuries a series of enlightened popes undertook to establish rural centers, or *domuscultae*, particularly on the sites of ancient cities: to the right of the Tiber, Capracorum (now Isola Farnese near ancient Veii), Galeria near the ancient station of Ad Careias on the Via Claudia, and another Galeria farther south (Castle of Guido); between the Tiber and Aniene the *domuscultae* of Monte Gentile, Castellarcione, and Pratolungo; between Rome and the Alban Hills, Sulpiciana (between Capannelle and Marino) and la Falcognana; between Rome and the sea Calvisiana and Laurentina, etc. But in almost every case the settlement lasted only a short while.

Somewhat later there arose certain minor centers which would seem to have been somewhat more successful. These were known as

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[8] The ingenious hypothesis of Ellsworth Huntington, according to which the fluctuations in the intensity of malaria and in conditions either more or less favorable to agriculture and population in the Campagna depend upon the alternation of periods of greater or less dryness, cannot, in the writer's opinion, be considered as proved, owing to the lack of the necessary corroborative data. Cf. Ellsworth Huntington: Climatic Change and Agricultural Exhaustion as Elements in the Fall of Rome, *Quart. Journ. of Economics*, Vol. 31, 1917, pp. 173–208.

[9] Giuseppe Tomassetti: La Campagna Romana antica, medioevale, e moderna, 3 vols., Rome, 1910–1913.

coloniae (possibly the relics of the ancient *villae*), *curtes* or *curiae*, and more particularly as *castra* or *casalia*. The last, often surrounded by walls and towers, served as the strongholds of the Roman barons, between whom severe and long-lasting feuds broke out which often culminated in pillaging, burning, and raiding. All this contributed to keeping the country in a desperate state. The power of the feudal lords, which some of the popes and later the Commune of Rome itself sought in vain to restrain, reached its height in the thirteenth and fourteenth centuries. These nobles possessed immense *latifundia* which they dominated from castles erected on the ancient highways and connected by systems of intermediate fortified posts and watch-towers; the villages by necessity had to place themselves under the protection of one or the other of the barons, who in this way became their immediate masters. Many of the small centers nearer Rome were deserted by their inhabitants, who preferred to retire behind the walls of the city. Agriculture was more and more neglected, and herding became widespread over large tracts that had reverted to pasture.

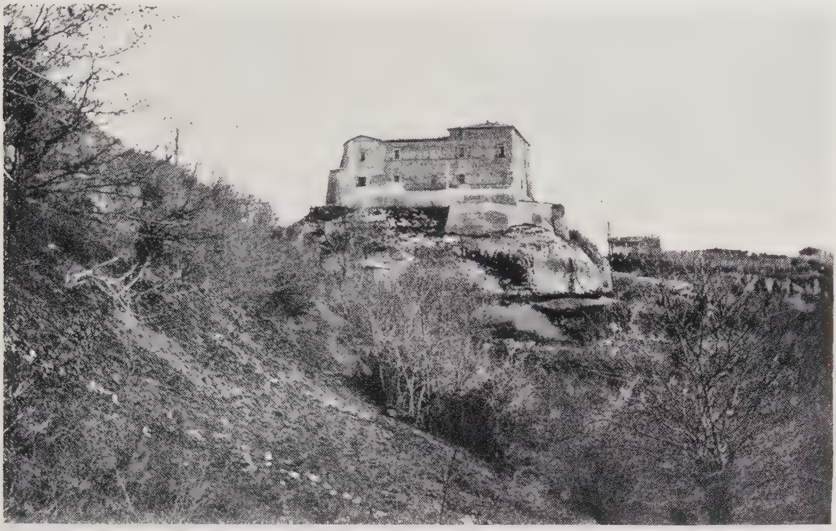

FIG. 3—The *casale* of Corcolle.

In this way at about the end of the fifteenth or beginning of the sixteenth century there became established in the Roman Campagna a form of economic life whose vicissitudes may be followed down to our own day. A vivid picture of the situation at the end of the sixteenth century is provided by the great map of the Campagna by Eufrosino della Volpaia, dated 1547. Here the territory surrounding Rome over a radius of about twenty miles is drawn with such exactness that most of its cultural features can be identified. The Campagna appears as an undulating tract broken by *fossi* and ravines; roads radiate from Rome; hamlets are shown, together with many conspicuous ruins and a multitude of watchtowers; cultivated lands are of very limited extent, almost wholly confined to the flanks of the hills of Tivoli and Montecelio, to the region between Zagarolo and the Aniene, and also to the south side of Lake Bracciano; almost everywhere else spread pasture lands; small ponds, pools, and marshes are frequent. Large tracts covered with *macchia* and brush abound in big game. Hares, wolves, and deer may be seen in the wood of Zagarolo.[10]

From the end of the sixteenth century we have an accurate register of all the estates in the Roman Campagna with the names of their possessors; a precise cadastral survey was carried out by Alexander VII about 1660.

The Great Estates

The Commune of Rome is divided into three parts: the city within the ring of walls; the suburbs, forming a narrow and irregular zone of very small holdings given over to gardens and vineyards; and the Agro Romano. The last is divided into estates (*tenute*) that vary greatly in extent, some being as large as a whole commune and others fairly small. Great proprietors have long been the owners of most of the estates, the total number of which, despite frequent transfers, was not greatly changed until a few years ago. At the time of Alexander VII (1655–1667) there were 425 estates; in 1770, 409; in 1890, 388; and in 1911, 413.

The center of each estate is the *casale*, with its fountain (Fig. 2). Each *casale*, or center of rural enterprise, is a massive, rectangular structure, surrounding an interior court. The latter, open to the sky and as large as a city square, is approached by a single gate. The building not only houses the personnel in charge of the estate but provides room for the storing of produce, and in the broad courtyard it is also possible, when necessary, to find place for the live stock. Attached to or built into one of the four corners of the structure there is usually a chapel.

In many instances the original plan of the *casale* has been modified. During periods of conflict between the great feudal lords or during times when brigandage flourished the edifice was fortified with towers and battlemented walls in such a way that it became a veritable miniature fortress equipped differently at different epochs according to changes in the art of military engineering.

The grandest and most beautiful of the *casali* were built on elevations that correspond, in some cases, to the citadels of ancient ruined cities—as the Castel Giubileo on the *arx* of Fidenae, Castiglione on the *arx* of Gabii, Lunghezza (possibly on the *arx* of Collatia), Corcolle (Querquetula?), Castel di Leva (*arx* of Bovillae). Other *casali* represent *domuscultae* and *coloniae* of the Middle Ages. In the drier zones their position is often determined by the proximity of water; still other *casali* dominate points which roads must pass or where roads cross watercourses.

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[10] This very rare map has been reproduced and is explained in great detail by Thomas Ashby: Mappa della Campagna Romana del 1547 di Eufrosino della Volpaia, Rome, 1914.

In some cases out of an enlarged *casale* a small village has developed, whose origin is manifest in the form and arrangement of the houses and in the single entrance gate through the surrounding walls. Such for instance are Practica, S. Vitorino, and Isola Farnese.

Until a few years ago these estates were in the hands of great proprietors, usually the owners of over 5000 hectares apiece. The proprietors themselves in the majority of cases did not exercise personal supervision but managed their estates through agents known as *mercanti di campagna.* The principal work on the estates was stock raising, the cultivation of grain being only of secondary importance. For the latter purpose the best soils on the level areas were used, where it was the custom to till the soil for two years in succession, alternating with two, or at least one, year during which it was allowed to lie fallow and was used as pasture (the system of *quarteria* or *terzeria*). The raising of horned cattle, including Swiss milch cows, attained a certain importance in the Campagna. Forage was procured by irrigating the meadows. Even now big half-ruined stables capable of holding 200 head of cattle and more are not an unusual sight. The raising of horses also was of considerable importance. The poorest pasturage was left to the sheep.

The common opinion that in the past the Roman Campagna was an almost entirely unused tract is erroneous. On the contrary, a traditional system of rural economy prevailed which had become adjusted to the complex of natural and social conditions and from which the great proprietors derived considerable profit with very little responsibility. The latter circumstance made it very difficult to effect any changes in the system, even though its maintenance was most unfortunate from the larger point of view of society as a whole.[11]

The Shepherds and Their Flocks

The evils of the agricultural system appear to have grown much worse between 1650 and 1800. This, as we have already seen, was

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[11] There are many studies of the traditional economic system of the Campagna. One of the most widely known of these is Werner Sombart: La Campagna Romana, translated into Italian by F. C. Jacob, Turin, 1891. In the present writer's opinion the best treatment is that of Ghino Valenti: La Campagna Romana e il suo avvenire economico e sociale (estratto del *Giornale degli Economisti,* 1893), reprinted in his "Studi di politica agraria," Rome, 1914, pp. 145–252. Fundamental from the historical point of view is the book of C. de Cupis: Le vicende dell'agricoltura e della pastorizia nell'Agro Romano, Rome, 1913. By the same author is a bibliographical essay relating to the documents and laws concerning the Ager (Rome, 1903) with a supplement up to 1925 (Caserta, 1926).

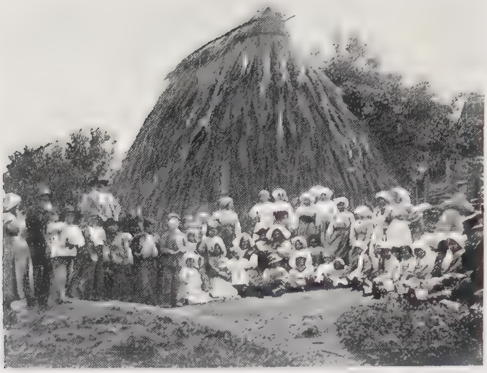

FIG. 4

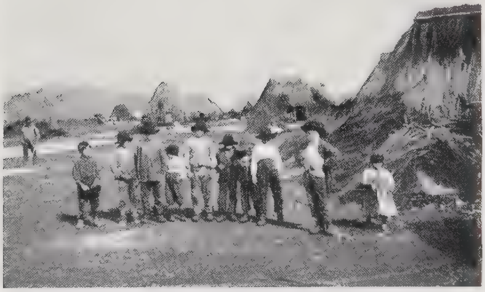

FIG. 5

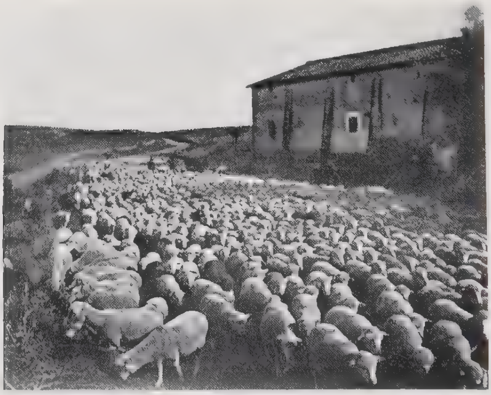

FIG. 6

FIG. 4—Hut near the old village of Marcelli and inhabitants of the village.

FIG. 5—Hut village of Vivaro.

FIG. 6—Flocks of sheep leaving the Campagna for the Abruzzi at the end of June.

probably the saddest period in the entire history of the Campagna, at least during modern times. A recrudescence of malaria led to the final abandonment of certain inhabited places, more particularly north of the Tiber between the Via Cassia and the Tyrrhenian Sea (for example, Galeria) and also south of the river in the zone nearest the sea. The pasturing of sheep flourished at the expense of other forms of rural economy, becoming its characteristic feature.

The shepherds, almost exclusively natives of the Abruzzi, pass the summer months with their flocks in the mountains of the Abruzzi. With the first cold weather during the second half of September they come down into the plains, retiring to the mountains after the middle of June. Thus the roads of the Campagna twice a year, towards the end of September and in June, offer an unusual spectacle. They are invaded by enormous flocks of sheep crowding together over stretches several hundred meters in length and stopping all traffic. With the aid of huge, fierce white dogs the shepherds drive them slowly forward taking ten, twelve, or fifteen days for the journey from the plains to the mountains and vice versa. During the winter period the sheep in the Campagna do not occupy folds but remain out in the open air, inclosed at night in characteristic corrals made of a network of twine and known as *procòi*, "the same sheepfold as that which was used in the Caesars' time." The shepherds live in very primitive isolated straw huts. These are usually conical with a single low entrance and no other opening. There is a fireplace in the center, and around the sides are straw beds covered with skins—four, six, or sometimes eight beds to each hut. The furnishings in general are reduced to the indispensable minimum. Conveniently located near both herds and shepherds' huts are the milking places, circular enclosures. Such a characteristic establishment, known as *stazzo*, is completed by a little garden and sometimes by a row of small straw pens occupied by a few swine.[12]

The peasants who used to work by the day, particularly at harvest time, in the areas where grain is cultivated were also tempo-

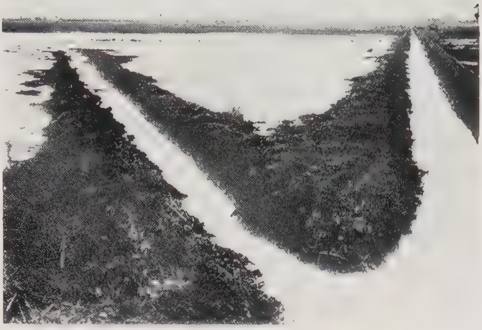

FIG. 7

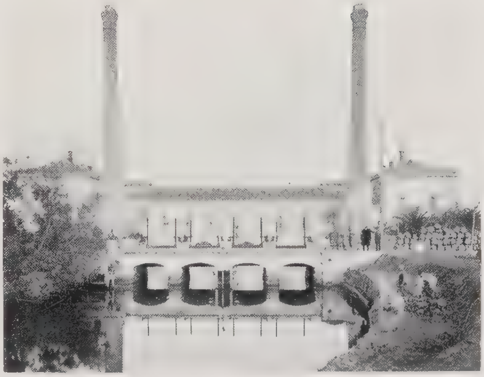

FIG. 8

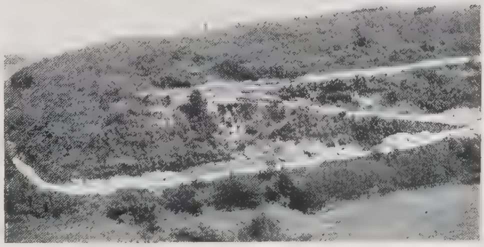

FIG. 9

FIG. 7—A typical view in the Maccarese region before reclamation.

FIG. 8—Pumping station of Maccarese.

FIG. 9—One of the new roads of the Campagna that link up the old system of radial highways.

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[12] Much has been written on the manners and customs of the shepherds of the Roman Campagna. See Ercole Metalli: Usi e costumi della Campagna Romana, Rome, 1903; Giorgio Pullè: La pastorizia nella Campagna Romana, *Riv. Geogr. Italiana*, Vol. 22, 1915, pp. 490–501.

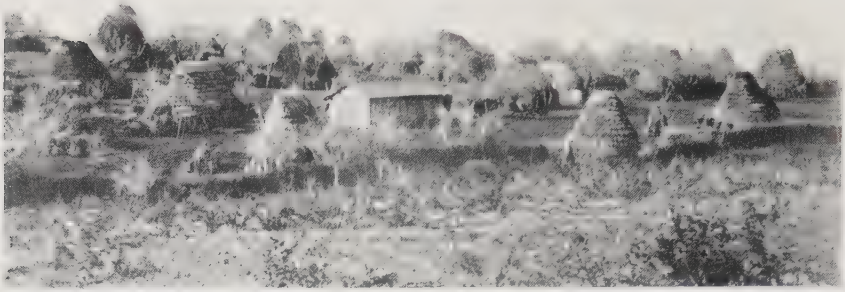

FIG. 10—The hut village of Marcelli. Compare Figure 12.

rary inhabitants of the Campagna. They came from the more poverty-stricken regions of the Apennines and calcareous Subapennines of the vicinity of Rome and from the Abruzzi (Aquilani). They sojourned either in the *casale* or more often in straw huts quite as primitive as those of the shepherds but somewhat different in structure. Unlike the shepherds' huts, these were not isolated but were usually clustered in small groups, some of which were large enough to seem like villages. These people used to leave the Campagna a little later than the shepherds, in the middle of July. Thus during the summer period the height of desolation was reached.

The economic régime based on sheep pasturing was further strengthened because the shepherds of the Abruzzi who in the past had wintered in the plains of Umbria and the Marches now found themselves excluded from these regions, which had at length been given over to agriculture. They turned to the Campagna, offering ever higher rentals for the use of the pastures. The owners of the land were thus confirmed in their determination to maintain a system which enabled them to gain returns from their property not at all inferior to those received from agricultural land and a system which required almost no outlay of capital. The connection between the rural economy of the Campagna and that of the Abruzzian Apen-

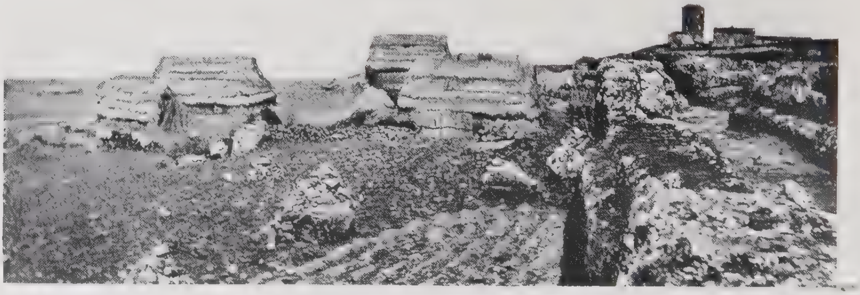

FIG. 11—Peasant huts near the *casale* of Castiglione (Gabii) in 1908. Compare Figure 13.

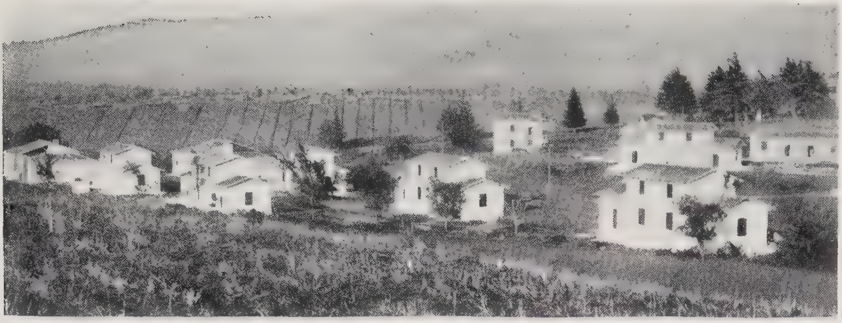

FIG. 12—The *borgata rurale* of S. Cesareo which has taken the place of the hut village of Marcelli (Fig. 10).

nines became closer; and thus became crystallized the economic system which the Italian government found rooted in this region when in 1870 the Roman territory was joined to the new Kingdom of Italy. An improvement, however, took place during the nineteenth century through the intelligent but almost unknown work of the shepherds of the upper Abruzzo, especially of the Vissani, who introduced and spread over the Campagna a new breed of sheep based on the selection and crossing of different types of merino. This new breed is characterized not only by its great strength but by its very fine wool and, when it finds good pasturage, also by its excellent and abundant milk. Its introduction led to an increase in the making of a type of cheese (*pecorino romano*) in great demand in the markets of central Italy. A veritable industry thus arose which has lasted to the present day, although it is now monopolized by a few large producers who turn out the finished product from modern plants in which a high degree of technical efficiency has been attained.

THE BEGINNINGS OF RECLAMATION

When Rome became the capital of the new Kingdom of Italy in 1870 the crying need for the reclamation (*bonifica*) of the Campagna

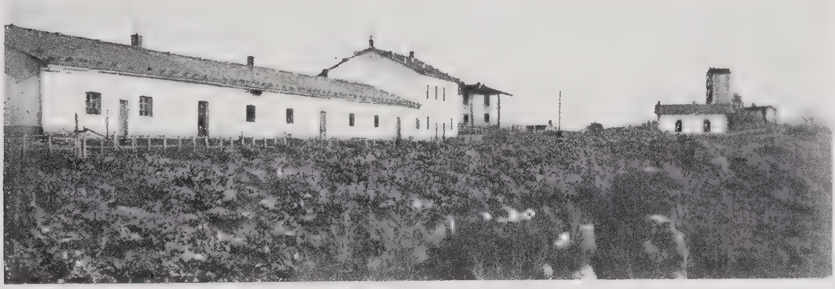

FIG. 13—Modern buildings which have taken the place of the old huts near the *casale* of Castiglione (Fig. 11).

received prompt recognition. At the very gates of the capital lay a vast, unhealthy, and depopulated tract when the collective interest of the country demanded as a solution for the problem of its rapidly growing population new lands for the planting of crops, the gradual reduction of the *latifundia*, and the repopulation of the rural districts. Based on truly notable investigations, the laws of December 11, 1878, and of July 8, 1883, provided for a whole series of undertakings in the fields of hydraulic engineering and agricultural reclamation in the territory around the capital. The state was under obligation to carry out the drainage of the greater part of the marshy areas near the mouth of the Tiber, including the marshes of Maccarese to the north of the river, those of Ostia to the south, and of the Isola Sacra between the two branches of the Tiber. The drainage of other small ponds and low-lying swamps scattered over the Campagna was also provided for. Obligatory hydraulic syndicates were to undertake the connection of the springs, regulating the *fossi*, and, indeed, bringing under control the whole drainage system of the Campagna; individual proprietors were committed to the agricultural reclamation of all the lands surrounding Rome within a radius of ten kilometers from the *milliarium aureum* in the Forum.

Hydraulic reclamation in the coastal area was accomplished by the establishment of pumping stations and by the construction of a network of drainage canals to carry off the water to the sea. In this way there was drained, as a result of operations of great technical interest, an area of about 215 square kilometers (Maccarese, 108 sq. km.; Ostia, 94 sq. km.; Isola Sacra, 13 sq. km.). A part of the area lay beneath the normal level of the sea and presented conditions analogous to those prevailing in the *polders* of Holland. But this hydraulic reclamation, which may be said to have been brought to completion, was not immediately followed by agricultural settlement; since sanitary conditions remained unfavorable, the ground was left uncultivated or was used as pasture. At Ostia, to be sure, a colony of peasants from the Romagna was established. These people, after a victorious struggle against malaria during the first period of their settlement, built up a flourishing new agricultural center, which numbers at the present time (1927) about 1000 inhabitants. This was the initial step towards the repopulation of the coastal region of Latium, a movement very slow at the outset but one which has gradually gained in momentum, as we shall see below.

Among minor hydraulic undertakings are the draining of the swamps of Baccano and Stracciacappe near Lake Bracciano, the draining of the ancient Lake Regillus (Pantano di Castiglione), the regulating of the Fosso Almone, etc.

In the Roman Campagna proper, however, reclamation of agricultural lands and repopulation made little progress during the last thirty years of the nineteenth century. This was due partly to the failure of the great landowners to carry out the duties imposed on them by law and partly to the persistence of malaria, against which no systematic campaign could be undertaken because of lack of adequate funds and for other reasons.

However, even before the Italian state intervened to promote the work of reclamation, a movement interesting from the geographical standpoint had already begun. Between 1860 and 1870 along the eastern and northeastern margin of the Alban Hills—which constitute a densely populated oasis devoted to the intensive cultivation of vines and olives—peasants from the poorest villages of the Apennines and from the calcareous Subapennines (such as Capranica Prenestina, Rocca di Cave, etc.) began to establish themselves. This folk came as temporary settlers during the period when agricultural labor was needed. They constructed hut villages often of considerable size (60 to 80 huts and more) but very primitive both in their construction and in their interior furnishings. Such habitations, suited for residence during the summer months, were at first occupied solely at this time of year. However, the period each year during which the inhabitants lingered in these settlements began little by little to grow longer, and finally the original mountain homes were abandoned altogether in favor of the new centers in the Campagna. The most important of these were Marcelli near S. Cesareo, Colle di Fuori and Carchitti farther south, Salto del Lupo near Pantano, Granaraccio near Aniene, Vivaro on the southern slope of the Alban Hills. For several decades these new colonists lived on in their primitive huts within a few kilometers of the capital of Italy quite unknown to the general public, without the benefit of medical or religious service, and without schools. Their settlements made a singular and disturbing impression on every visitor. But sooner or later the hut village, become permanent, tends to undergo a transformation, as we shall describe later. For the primitive hut with only a single entrance, dwellings of a more solid type two or three stories high have been substituted. Fires frequently destroy the older habitations, which are then replaced by new ones, often with walls. A few years hence the old, primitive type of habitation will perhaps have become only a memory of the past, but even today anyone who wishes to study the dwellings and their furnishings may find them in their most rudimentary state at Vivaro, the remotest and most completely isolated village of this unusual type in the neighborhood of Rome.

Reclamation Measures

The most recent phase of the movement toward the reclamation and repopulation of the Roman Campagna, a phase that has brought really decisive results, may be said to have begun with the twentieth century. According to the laws of December 13, 1903, and November 10, 1905 (the latter coördinated all previous legislation, *Testo Unico*), the zone in which reclamation from the hydraulic and sanitary points of view was made obligatory on the part of the landowners was extended, particularly on the east beyond the radius of 10 kilometers from the Forum; in the watershed of the Aniene it was carried to the base of the Alban and Tiburtine Hills (in all, an area of about 440 sq. km.). A whole series of elaborate projects was authorized: provision of water for drinking and for use in irrigation, opening of connecting roads, and construction of dwellings for permanent and temporary laborers and of stables for live stock. The law of July 9, 1910, extended still farther the zone to be reclaimed, particularly on the north and on the west towards the sea. Subsequent provisions made in 1919, 1921, and 1926 included definitely in the zone of reclamation all the territory of the Commune of Rome and of the neighboring communes of Anzio and Nettuno, a part of the valley of the Tiber above Rome, etc. Provision was made in clear and forceful terms for the promotion of every useful enterprise in the field of reclamation and especially for projects for the erection of centers of agricultural colonization and rural habitation.

The progress of this work may be followed with the aid of the valuable official reports and statistical publications of the Commune of Rome[13] and on the topographic maps of the Campagna on the scale of 1 : 25,000, revised in 1924–1926 and recently completed by the Istituto Geografico Militare.

The warfare against malaria—systematized only after the discovery of the carrying agent or Anopheles—has been conducted energetically during the last few decades. It has been facilitated (at least, according to the views of Celli) by the circumstance that toward the middle of the nineteenth century a new period of natural attenuation of the disease seems to have set in. Scientific research has also played an important part in this campaign. Preventive measures (such as the wholesale distribution of quinine), a better food supply, and consequently increase in vigor and power of resistance on the part of the population, the use of metal screens on the doors and windows, the elimination of ponds, pools, and partially flooded areas, etc., have all contributed toward the successful outcome of this struggle which today seems a foregone conclusion. While only thirty years ago one might easily contract malaria at the very gates of Rome, today the disease is not a menace in any part of the Campagna except in certain coastal zones, from which, without doubt, it will be eradicated in its endemic form in the near future. The virtually complete eradication of malaria thus brought about was absolutely necessary before repopulation of the region could be seriously considered.

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[13] Of especial importance are: Ministero di Agricoltura, Industria e Commercio: Il bonificamento dell'Agro Romano, Stato dei lavori al 30 giugno 1914, Rome, 1915; Ministero dell' Economia Nazionale: Il bonificamento dell'Agro Romano dal 1915 al 1925, Rome, 1925; *idem:* L'Agro Romano nel primo quinquennio fascista, Rome, 1928. The Commune of Rome has published the detailed results of the census of population of 1911, in which is presented among other things the population of all the estates of the Campagna on June 10, 1911. (Cf. Comune di Roma, Servizio di Statistica: Il censimento 10–11 giugno 1911 nel Comune di Roma, Rome, 1915, and Dizionario topografico di Roma, Rome, 1914.) Unfortunately, there is no analogous publication for the census of 1921.

Cultivation of many tracts formerly untilled and used solely for pasture has been made possible by the breaking up of the *cappellaccio* by means either of explosives or of Fowler machines which plow up the soil to a considerable depth. In the first operations of this sort, which date from the years following 1918, the explosives used for the most part were those left over from the World War. After these initial experiments had proved successful the work was entrusted to a special company (the Society for the Mechanical Breaking-up of the Soil in the Agro Romano), whose business it has been to make ready large areas for the cultivation of grains or, indeed, here and there for the planting of gardens.

Another notable objective may now be said to have been reached: the providing of drinking water and water for irrigation. In some places new sources have been utilized; for example, on the flanks of the Alban Hills the Barbuta aqueduct distributes drinking water to new colonization centers. The Acqua Marcia, coming from the sources of the Alto Aniene—foremost among the waters which used to supply the city of Rome—is now being distributed more especially in the region between Tivoli and Rome. Many small and unimportant springs have been tapped and brought into connection with one another to irrigate areas formerly dry. On a larger scale recourse is being made to the water found everywhere beneath the surface. In places this provides an abundant supply, the depth and flow of which are well known as a result of many surveys. At an earlier period water was sought for through the restoration of ancient wells; but today borings are often made to very great depths (as much as 50 to 60 m.; at Torrenuova even to a depth of 82 m.), modern contrivances being used for lining these artesian wells with metal. In this way it has been possible to make use of sources of water more abundant and of more constant flow. The water is raised by windmills and by different types of electric pumps and is stored in reservoirs.

One of the enterprises that has exerted a most powerful influence upon the repopulation of the Roman Campagna has been the construction of a new network of roads, especially a system of transverse roads binding together the main ancient highways so that the Agro Romano is now broken up into a series of concentric belts at different distances from the city (see Fig. 1). Up to 1915 about 32 kilometers of these roads had been constructed; at the end of 1928 the state and the communal government of Rome had completed about 285 kilometers. Besides these, there are also lesser roads built by the reclamation organizations (150 km.) and farm roads built by private individuals or syndicates. The construction of light railways has been of great benefit to the Campagna, notably the lines from Rome to the Alban Hills, to Fiuggi, to Civitacastellana, and to Ostia. The building of bridges over the Aniene and other watercourses also deserves mention.

The *latifundia* are being broken up little by little and subdivided either among small proprietors or into cultural units of modest area. The total area of the estates—now a little less than 1850 square kilometers—has grown somewhat smaller during recent years because many nearest the city have been included in the tract reserved for urban buildings or else have been broken up into small suburban plots for market gardens. Furthermore, a narrow belt along the base of the Alban Hills has been absorbed into the great zone of vineyards and olive trees which is extending from the hills towards the plain. Of the remaining area (1820 sq. km.) about 250 square kilometers has already been broken up or is being broken up into small farms. Another 250 square kilometers is being divided among 330 small holdings (from 50 to 100 hectares); 291 square kilometers among medium-sized holdings (from 100 to 200 hectares); 134 square kilometers among large holdings (from 200 to 300 hectares); about 100 square kilometers among centers combining agriculture and stock raising; and more than 190 square kilometers among little pastoral centers which make use of the natural meadows that have been improved for the purpose. Many other estates are in the process of transformation. The traditional type of exclusively pastoral economy in the Campagna is now restricted to a few large estates, perhaps 25 or 26, comprising a total area of about 282 square kilometers (10 to 12 sq. km. to each estate on an average); these are found for the

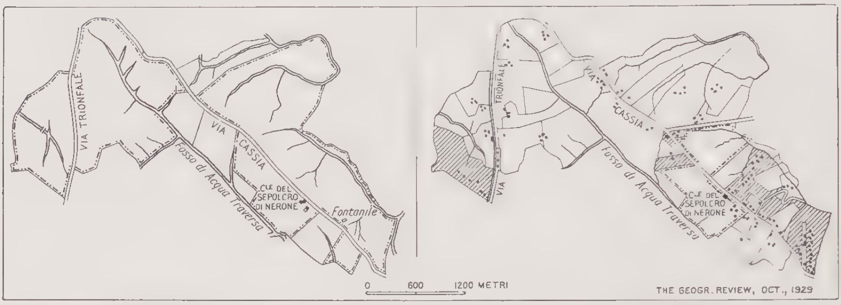

FIG. 14—On the left a great estate of the Roman Campagna in 1908: a single property of 6.73 square kilometers area whose economy was predominately pastoral. On the right the same estate subdivided in 1927. About the old *casale* is an agricultural center of 0.68 square kilometers; the remaining area is divided into 32 farms, each with a farmhouse; the obliquely shaded areas are divided into small lots with 70 cottages.

most part in the least accessible zone northwest of Rome and along the coast.

TYPES OF SETTLEMENT

We come now to the problem of how the repopulation of the Campagna is actually taking place. Isolated colonists' houses on farms of modest extent, such as are found in Tuscany, are still relatively rare. They occur for the most part not very far from Rome in areas adapted to varied cultivation, well provided with water, and where small holdings are profitable. One of the most conspicuous examples lies north of Rome along the Via Cassia. Here a great estate known as the Sepolcro di Nerone up to about twenty years ago comprised one of the traditional pastoral centers with its single ancient *casale* (at 8 km. from Rome on the Via Cassia). Since then this estate has been split up: a large agricultural center (68 hectares) and a cluster of new buildings have appeared near the ancient *casale*, 110 small farms with 95 colonists' houses have come into existence.

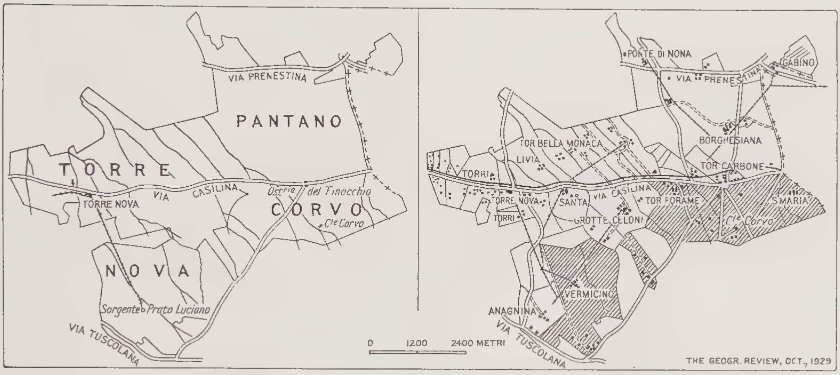

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FIG. 15—On the left three large estates with two *casali* still belonging, in 1908, to a single proprietor. On the right the same property at the end of 1927, subdivided into 18 agricultural centers with 14 groups of buildings, 26 farms with 22 farmhouses, and many small lots (obliquely shaded area) with rural cottages.

Of more frequent occurrence, however, are more complex centers of colonization corresponding to a larger territorial unit and including several buildings used as dwellings, stables, and storehouses for agricultural products. On the immense estates of Pantano, Corvo, and Torrenova, belonging to Prince Borghese, a radical transformation has been wrought by the completion of extensive works of reclamation and by a comprehensive road-building program through the initiative of the members of this ancient family. On land formerly almost exclusively devoted to pasture and uninhabited (except for three ancient *casali*, centers of old pastoral units) there are today some fifteen active and prosperous agricultural centers, besides a vast zone broken up into small lots. There are now several hundred agricultural centers of various types and characters, according to the prevalent form of cultivation. Some of them are quite complex, especially where stock raising is associated with agriculture. Many types of agricultural economy, well developed throughout the ages in the valley of the Po, have been experimented with. Centers that have grown up during the last few years have been given forgotten classical names: Collatina, Cornelia, Lucrezia. Schools for colonists have also been established, such as the one at Buffalotta, fully provided with a complete modern equipment. Here it is proposed to train agricultural experts and technicians in matters relating to rural industry and stock raising.

Larger centers, or villages in the Italian sense of the word, are already fairly numerous, whereas there were almost none up to a few years ago. As regards origin four different types of village may be distinguished.

The first type, of which we have already spoken, is the hut village, representing a transitional stage in the agricultural settlement of the Campagna. Having become permanent, the village tends to change; in some cases in place of the single huts large buildings have been substituted, each one accommodating up to twenty families (Pantano, Granaraccio); elsewhere the huts have been superseded by walled cottages, as at S. Cesareo. Here, today, dwell some 150 families to each of which a hectare and a half of land has been assigned. Thus a veritable center of colonization has sprung into existence, with a population of 800 inhabitants. Such a center is usually called a *borgata rurale*, a term applied to an agricultural village constructed *ex novo* in territory formerly quite uninhabited.

These *borgate rurali* constitute the second type of settlement, a type which had previously been tried out successfully in Apulia. The first *borgata rurale* in the Campagna was founded in 1911 at 7 kilometers from Rome near the station of Magliana on the route from Rome to Pisa; at the present time it houses about fifty families. As a typical example, the *borgata* of Acilia may be taken; this has developed since 1913 in territory previously devoted to pasture and wholly uninhabited. Here in the form of a quadrangle (about 400 by 900 m.) twelve buildings were first constructed, all exactly alike and each housing four families. To each family was assigned a half hectare of land to be devoted wholly to the culture of garden products. In the middle of one side of the quadrangle, which paralleled the railway from Rome to Ostia, a street six meters wide entered the enclosure. This street was crossed at right angles in the center of the quadrangle by another street. Very close to the place where the first of these streets opened out on the railway is the railway station; and close at hand is a square with the school, the post office, the sanitary station, the barracks of the *carabinieri*, and a few stores. According to the

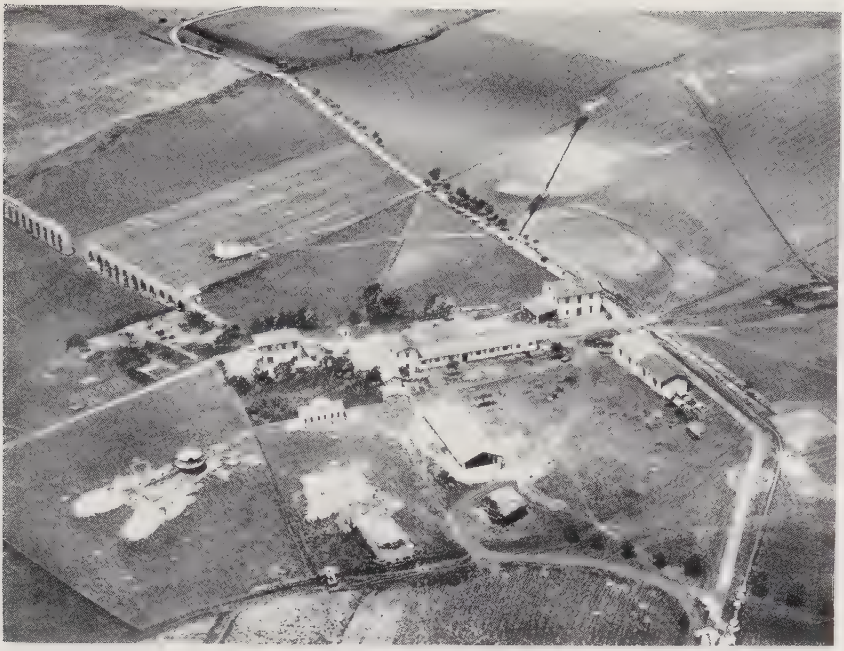

FIG. 16

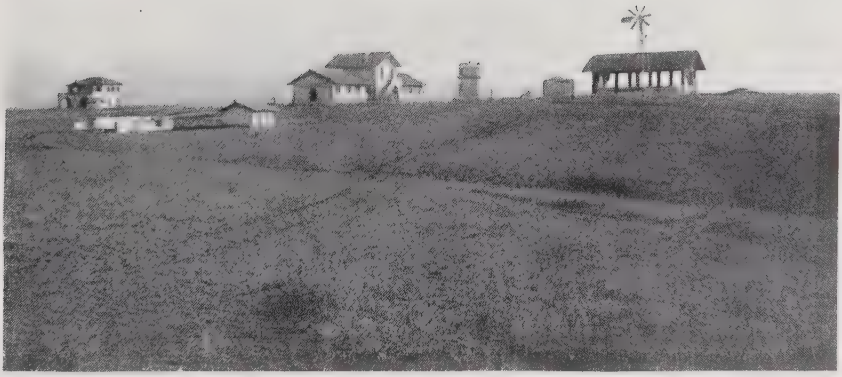

FIG. 17

FIG. 16—The agricultural center of Casetta Mattei. To the left the ruins of a Roman aqueduct.
FIG. 17—The agricultural center of Salone.

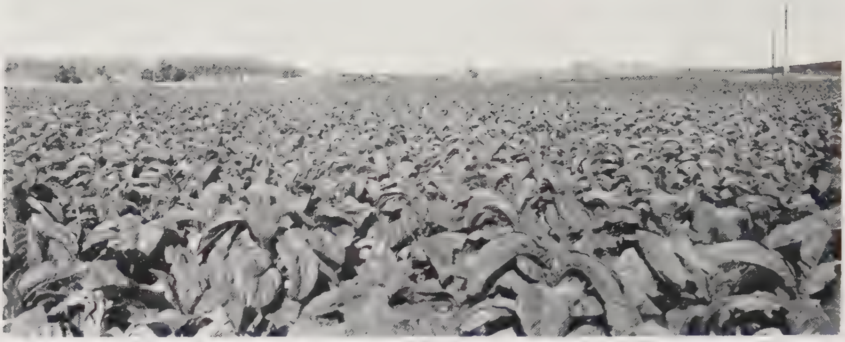
FIG. 18

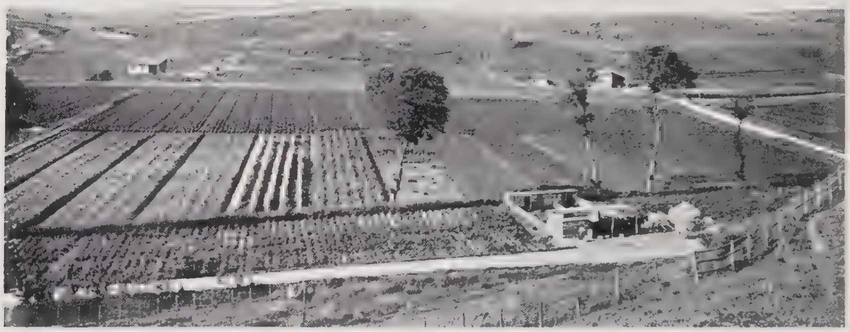
FIG. 19

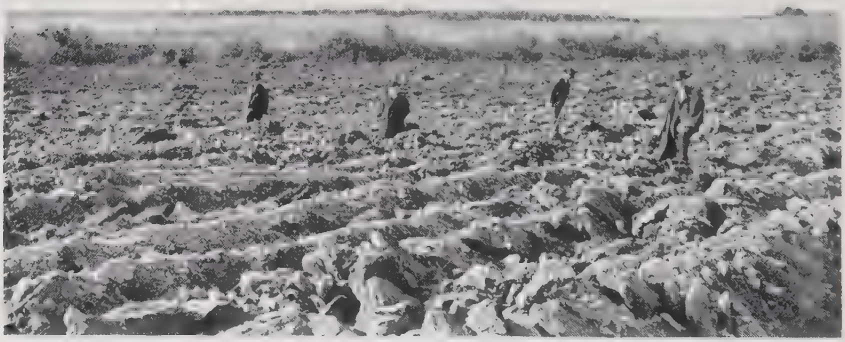
FIG. 20

FIG. 18—Agricultural center of Pratolungo; cultivation of tobacco.
FIG. 19—Land reclaimed for cultivation in the valley of the *fosso* Acquatraversa.
FIG. 20—Soil broken up by Fowler machine.

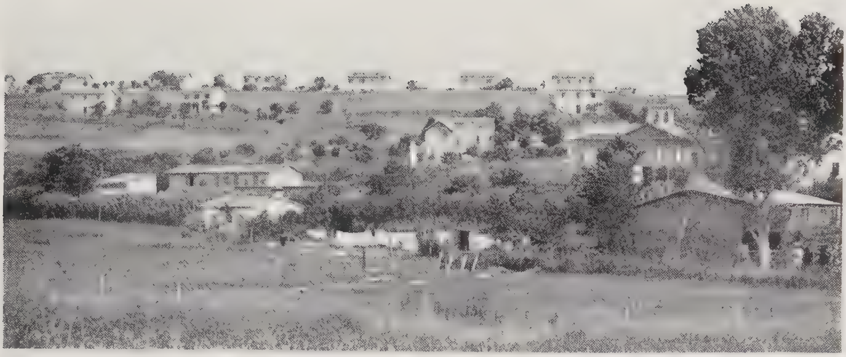

FIG. 21

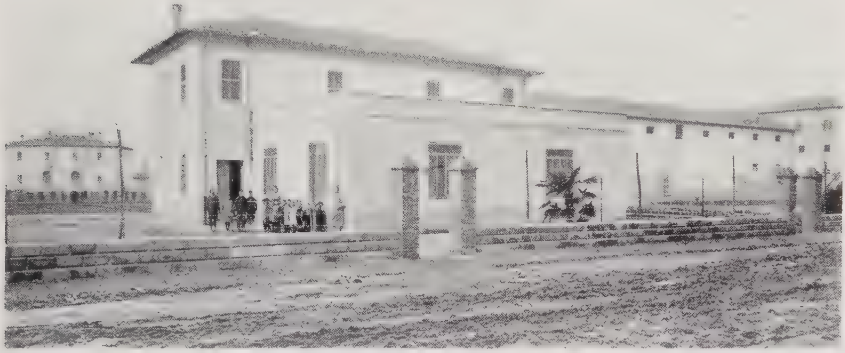

FIG. 22

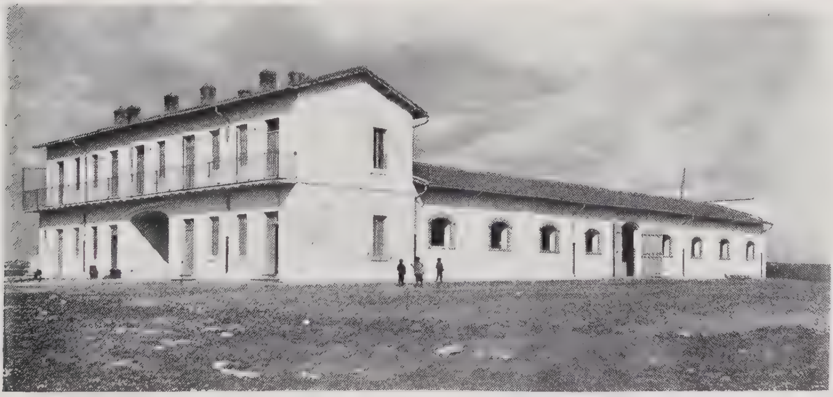

FIG. 23

FIG. 21—The *borgata rurale* of La Magliana.
FIG. 22—School in the agricultural center of Maccarese.
FIG. 23—Building with quarters for the farmers and stables for cattle.

census of 1921 the *borgata* had 454 inhabitants. Since then it has been much enlarged by the construction of new rural buildings; according to a survey made in June, 1927, it had 735 inhabitants. Other *borgate rurali* are Barbuta on the Via Appia Nuova at 11 kilometers from Rome, founded in 1914 (25 families); Settecamini on the Via Tiburtina, 11 kilometers from Rome, founded in 1916 (35 families); Centocelle, on the Via Casilina, 5 kilometers from Rome, founded in 1921 (30 families); Ottavia on the Via Trionfale, 6 kilometers from Rome, founded in 1921 (48 families); Tor Sapienza on the Via Collatina, 6 kilometers from Rome, founded in 1922 (30 families); Maccarese, south of the old *casale*, in a zone where agrarian reclamation, begun as late as 1925, is now rapidly proceeding.

Villages of the third type are those that have grown up around the old *casali*. Some of the more favorably situated of the *casali*—distant descendants of the *domuscultae* of the Middle Ages and thus of the even more ancient cities of classical Latium—are being adapted as centers for the revival of rural life in the Campagna. Around the massive ancient building which has to house an increasing number of people from year to year, new dwellings and associated structures spring up, stores are opened, churches are revived, and public services—post office, school, and sanitary stations—are established. The new center takes form not as an artificial creation, as in the case of the *borgate rurali*, but as a result of spontaneous growth. Here also in some cases temporary huts have been used before the construction of permanent places of residence. Thus at Castiglione, where twenty years ago ten or twelve miserable huts clustered around the old *casale* on the site of the citadel of Gabii, modern buildings with stables and storehouses are being erected as dwellings for the colonists; Lunghezza (possibly the ancient Collatia) on the Aniene has now become a real village. In some cases the attraction of a railroad station has stimulated the settlement of a new village.

The fourth type is that of the maritime centers. As we have already pointed out, the coast in the neighborhood of Rome until a few years ago was absolutely depopulated on account of malaria. Between Civitavecchia and Anzio the only inhabited places were the old *casali* of S. Marinella, S. Severa, and Palo and the locality of Fiumicino, at the northern mouth of the Tiber; and most of the few inhabitants were temporary visitors or else small colonies of Neapolitan fishermen. With the draining of the marshes and the progress of reclamation new villages have developed, nearly all of which have now become flourishing bathing places. Anzio (first called Porto d'Anzio) did not have a thousand inhabitants in 1853, but today (1928) it is a lively little watering place with more than 5000 inhabitants. On the coast where La Marina di Ostia now stands there was not a single house fifteen years ago. Today this place is rapidly becoming a veritable seashore suburb of Rome. Ladispoli, founded, as the name implies, by Ladislao Odescalchi on his great estates north of Palo, and very recently Fregene, on the shore near Maccarese, fashionable bathing resorts in the midst of a magnificent pine wood, have grown up out of nothing. The growth of these centers along the shore may be seen from the following table of inhabitants:

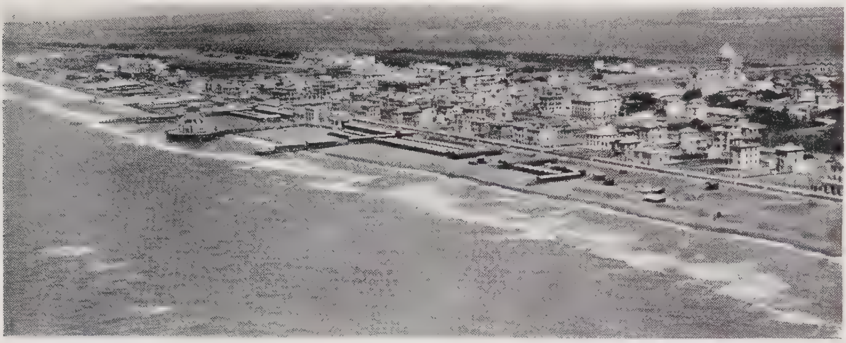

FIG. 24—Aerial view of Ostia Mare.

	1835	1901	1921	1927–1928
Anzio (center)	996	2481	4813	5500
Ostia (*borgata*)	...	427	570	955
Ostia Mare	...	...	233	779
Fiumicino	507	700	1178	1500
Ladispoli	...	30	428	550
S. Marinella	162	210	980	1300
S. Severa	130	90	437	500

The region of the Agro Romano least transformed up to date lies north and northwest of Rome between the Via Aurelia and the Via Cassia, and between the latter and the Tiber. Here, although a few new farming centers have appeared along the principal roads in the intervening districts settlement is proceeding quite slowly. The principal reason for this is probably to be found in the difficulty of access to this region, since it has been profoundly dissected by a fine network of torrents; furthermore, away from the old consular roads there still are no means of communication.

CHANGES IN LAND UTILIZATION

The most conspicuous result of the transformation in the system of landholding is the reduction of the natural pasture. Of a total of about 1820 square kilometers there remained as natural meadow in 1927 715 square kilometers, a figure which, it has been forecast, will be reduced to at least 500 square kilometers by 1930–1931. This reduction has been primarily in favor of the artificial meadows, particularly of lucerne, the area of which, from 43 square kilometers in 1922, rose to 325 in 1927 and will reach about 460 in 1930–1931 (i. e. a more than tenfold growth in less than ten years).

The cultivation of cereals has likewise been greatly increased. The area devoted to cereals, less than 150 square kilometers in 1922, rose to 320 square kilometers in 1927 and will reach 380 in 1930–1931. There have been even greater gains in horticulture and, subordinately, in the cultivation of fruit, olive trees, and vineyards. The area particularly devoted to these types of agriculture was only 18 square kilometers in 1922 but had risen to 91 in 1927 and will reach 120 in 1931. Irrigated lands, about 8 square kilometers in 1922, will reach 60 in 1931.

It is very important to note that the decrease of the area in pasture has not been accompanied by a falling off in the live-stock industry. The raising of live stock, whether of sheep or horned cattle, has been much improved both as to type and breed, since the animals are now fed on the yield of the artificial meadows as well as on that of the natural pasture and are sheltered for the most part in stables and confined to restricted areas instead of being allowed to wander over wide spaces. The construction of stables of a modern and sensible type is one of the most striking facts that accompanied the recent repopulation of the Campagna. More and more sheep can now pass the summer months in the Campagna, avoiding the long and tiresome migration to the mountains; thus the old practice of transhumance, which dates back to the beginnings of history, is now tending to disappear. In 1907 there were in the Campagna stables enough to shelter possibly 2000 horned cattle but no sheepfolds. The number of horned cattle housed in stables had increased to more than 10,000 head in 1922, to 20,000 in 1927, and will exceed 30,000 in 1931. In 1922, 11,000 head of sheep occupied sheepfolds, 31,000 in 1927, and in 1931, according to forecast, more than 93,000 sheep will be accommodated.

Growth of Population

In conclusion some figures may be given relating to the increase in the total population of the Agro Romano within the limits of the communes of Rome, Anzio, and Nettuno.[14] Of the most recent decennial censuses only those of 1901 and 1921 are comparable, because they were both taken in the winter; whereas the intermediate census of 1911 was taken in the summer (June 30) when the greater part of the temporary population had left; the first census gave the total population on the first of February as approximately 25,200 (13 per sq. km.), the second as approximately 38,500 (20 per sq. km.). According to estimates as of the end of 1927 the population of the Agro must have risen to 48,500; and it will exceed 55,000 in 1931, when the next census will be taken.

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[14] Excluding, however, the centers of Anzio and Nettuno.

The population which is establishing itself permanently in the Campagna is being recruited for the most part from three different sources: (1) from among the inhabitants of Rome, in the new *borgate* and other centers of colonization nearest the city—as, for example, Ostia Mare and other seacoast localities; (2) from among the population of the Subapennine communes in the vicinity of Rome (Capranica Prenestina, Rocca di Cave; Camerata Nuova, etc.); (3) from among the inhabitants of the Abruzzi. The last are not only shepherds and herders but also include a few small artisans or casual laborers. Details in regard to this, however, are quite lacking and would be difficult to gather.

All we have attempted to do here is to give a summary statement of the principal aspects of the phenomena of agrarian reclamation and repopulation in the Roman Campagna. Other features, less conspicuous at the present time, will appear more clearly when these phenomena have developed on a larger scale and more fully. We have shown, however, that the repopulation of the region surrounding Rome may be considered now as definitely under way. A radical change is taking place in the appearance of the Campagna, a change which from the social point of view may without doubt be regarded as highly salutary.

GREAT SLAVE LAKE

J. Mackintosh Bell

IN the northern part of western central Canada the immense basin of Great Slave Lake forms one of the great physical features of the earth's surface. Until a few decades ago the region where this fresh-water sea is situated was regarded almost as an *Ultima Thule* in its remoteness, but in recent years ordinary means of communication have seen such a marked improvement that the casual traveler to this region can no longer consider himself a pioneer of exploration. Its shores, indeed, can be reached in a few hours' journey by airplane from the present railway terminus at Fort McMurray. What an amazing change from the days of the early voyageurs!

Though the suggestion is advanced, and not without probable foundation, that *coureurs de bois* from French Canada were the first white men[1] to visit the region of Great Slave Lake, the honor of its official discovery belongs surely to that redoubtable young English explorer, Samuel Hearne. Hearne, on his remarkable voyage of exploration from Fort Prince of Wales to the mouth of the Coppermine River, whither he had been lured by Indian stories of copper treasure, on the outward journey followed a route which left Great Slave Lake far to the westward, but on his way back, traveling southward from the headwaters of the Coppermine, he reached Great Slave Lake or, as he calls it, Athapuscow, a short distance east of the northern arm, on December 24, 1771.[2]

Whether or not that pioneer of the fur trade in Mackenzie River region, Peter Pond,[3] traveled along the southwestern shores of Great Slave Lake, as has been alleged, it is clear that two of his traders, Laurent Leroux and Cuthbert Grant,[4] built a fort there in 1785, at or near an easterly mouth of Slave River, between thirteen and fourteen years after Hearne's visit; and to this northern outpost came Alexander Mackenzie on June 9, 1789,[5] on his way to the great river which bears his name and which forms the outlet of Great Slave Lake.

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[1] Émile Petitot: Autour du Grand Lac des Esclaves, 2nd edit., p. 78.

[2] Samuel Hearne: A Journey from Prince of Wales's Fort in Hudson's Bay to the Northern Ocean in the Years 1769, 1770, 1771, and 1772; new edit., by J. B. Tyrrell (Champlain Society Publs., Vol. 6), Toronto, 1911, pp. 253 et seq.

[3] H. A. Innis: Peter Pond and the Influence of Capt. James Cook on Exploration in the Interior of North America, *Trans. Royal Soc. of Canada*, Ser. 3, Vol. 22, 1928, pp. 131–141.

[4] L. J. Burpee: The Search for the Western Sea, Toronto, 1908, p. 416.

[5] Alexander Mackenzie: Voyages from Montreal, on the River St. Laurence through the Continent of North America to the Frozen and Pacific Oceans; in the Years 1789 and 1793: With a Preliminary Account of the Rise, Progress, and Present State of the Fur Trade of That Country, London, 1801, p. 7. (Reprinted as Vol. 3 of "Master-Works of Canadian Authors," Toronto, 1927.)

A small part of the southern shore of the lake is said to have been mapped by Philip Turner on the voyage which took him to the southern portion of the Mackenzie Valley between 1790 and 1792.

In the first half of the nineteenth century a number of distinguished geographers visited Great Slave Lake in the course of the explorations which were adding so greatly to the knowledge of the northwestern part of the continent at that period. On Franklin's first Canadian expedition[6] he crossed (1820) from the south shore to old Fort Providence on the northern arm of the lake, whence he departed on the expedition to the valley of the Coppermine River, fatal to so many of his followers; and on his second journey,[7] on his way to and from his headquarters on Great Bear Lake (1826–1827), he traversed the western arm. Back[8] followed the boat channel from the mouth of Slave River to the eastern end on his way to and from Fort Reliance (1833–1835), which he built to form the base of the explorations of the lakes to the northeast of Great Slave Lake and of Great Fish River now known by his name.

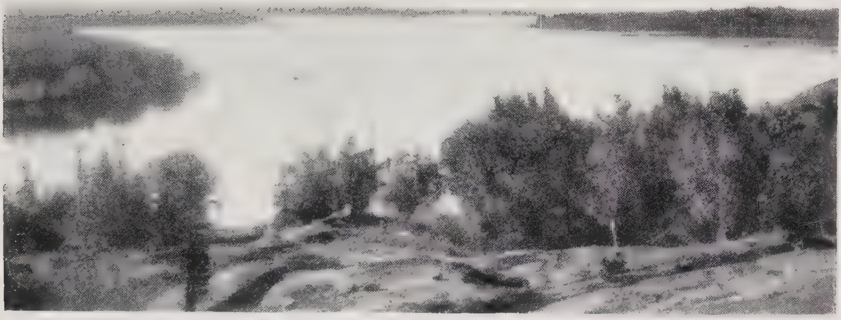

FIG. 1—The mouth of the Yellowknife River looking west towards the main portion of the northern arm of Great Slave Lake. Glaciated rock surfaces in the foreground; vegetation flourishing under the protection of surrounding hills. (Photographed by J. M. Bell.)

Though Mackenzie, Franklin, and Back each added accurate information to the knowledge of the nature of the region of Great Slave Lake, it remained for the venturesome missionary, the Abbé Petitot, to provide, as the result of his widespread wanderings in the sixties and seventies, the first comprehensive map of this part of Canada.[9] This extraordinary document, published in 1875, fundamentally inaccurate in detail but, when we bear in mind the multiplicity of islands and channels in the eastern part of the lake, giving a good impression of the general outline, remained for many years, with some modifications, the model accepted for the maps of northwestern Canada.

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[6] John Franklin: Narrative of a Journey to the Shores of the Polar Sea in the Years 1819, 20, 21, and 22: With an Appendix on Various Subjects Relating to Science and Natural History, London, 1823.

[7] John Franklin: Narrative of a Second Expedition to the Shores of the Polar Sea in the Years, 1825, 1826, and 1827: Including an Account of the Progress of a Detachment to the Eastward, by John Richardson, London, 1828.

[8] George Back: Narrative of the Arctic Land Expedition to the Mouth of the Great Fish River, and along the Shores of the Arctic Ocean in the Years 1833, 1834, and 1835, London, 1836.

Since Petitot's time Great Slave Lake has been visited by many surveyors and geologists of the Canadian Government staff, in the forefront of whom were McConnell and Ogilvie, and by numerous other scientists and explorers, including Pike, Hanbury, Russell, Preble, and Douglas. A complete survey of Great Slave Lake was made between 1921 and 1925 by the Topographical Survey of Canada, and an accurate map of the great lake is now available. Much credit is due Blanchet[10] and the other topographers engaged for carrying through to a successful conclusion operations conducted during brief field seasons on a large body of water subject, more particularly during the late summer and early autumn, to tempestuous storms.

If one compares this modern map with that which accompanies Hearne's fascinating narrative, one observes that the latter conveys little idea of the lake's conformation. His name for the lake, Athapuscow, meaning in the Cree language "grass or reeds here and there," has strangely enough been transferred in the course of time to the next great lake to the south, Athabaska, where, as in the case of the Slave River at Great Slave Lake, there are reedy meadows at the mouth of the Athabaska River. He describes the lake as being "about one hundred leagues long from east to west and twenty wide from north to south." Considering the league as being 3.456 statute miles, these dimensions indicate a length of 415 miles and a width of 69 miles. The actual length from the foot of Big Island, which may be considered the head of the Mackenzie River, to Fort Reliance is about 300 miles, and the greatest width about 70 miles.

Petitot indicates that the aborigines call Great Slave Lake Tthou Tpoué or the Lake of Breasts (Lac des Mamelles), presumably on account of the peculiar topography of the hills at the eastern end.[11] He states that the lake extends from longitude 112° to 119° 30′ W. of Paris and transversely from latitude 61° to 63° N. These generalizations as to the geographical extent covered by the lake approach accuracy, but it should be remembered that Petitot had the advantage of the astronomical observations made by the British geographers who preceded him.

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[9] Émile Petitot: Géographie de l'Athabaskaw-Mackenzie et des grands lacs du bassin arctique, *Bull. Soc. de Géogr. de Paris*, Ser. 6, Vol. 10, 1875, pp. 5–42, 126–183, and 242–290.

[10] G. H. Blanchet: Great Slave Lake Area, Northwest Territories, [Canada] Topographical Survey, Department of the Interior, Ottawa, 1926.

[11] Petitot, Géographie de l'Athabaskaw-Mackenzie.

McConnell gave the superficial area of Great Slave as 10,400 square miles.[12] Cameron, with the results of his accurate surveys of the western arm at his disposal, not available at the time of McConnell's visit in 1887, increased this extent by 2400 square miles, or to a total of 13,100 square miles.[13] The latest topographical maps, including those of the eastern portion made subsequent to Cameron's investigation, suggest an area considerably less than his figures. Accurate maps have not yet been made of Great Bear Lake, which differs materially in character from Great Slave Lake, inasmuch as it would appear from available information to contain fewer islands and to be generally much deeper. The existing maps indicate an area of approximately 11,400 square miles. It is doubtful if Great Slave is as large as the suggested figure for Great Bear; but, if not the fourth, it is at any rate the fifth largest lake on the American continent, being certainly exceeded in size by Superior, Huron, and Michigan.

Climatic Comparisons

Great Slave Lake extends over more than two degrees of latitude, and naturally the climate of the northern part of the basin is in general more severe than that of the southern, but its variability is more influenced by longitude than by latitude. While complete meteorological statistics are not available from a sufficient number of points on the lake to enable us to speak authoritatively or exactly, it would seem from the date of disappearance of the ice that the climate along the eastern arm is more severe than that along the northern, and the northern in turn is harsher than that along the western arm. The last comes to some extent under the influence of the warm winds that blow through the low passes of the Rockies and temper the weather even in winter. The climate of the western part is, in fact, milder than one would expect from its northern situation, being much less severe than the climate in corresponding latitudes farther east on either side of Hudson Bay. The three summer months are characterized by dry and generally bright warm weather. Sometimes even there are spells of oppressively hot weather when the temperature soars above 90° F. The summer isotherms of Fort Resolution and Fort Providence correspond with those passing through southeastern Manitoba and the valley of the St. Lawrence near Quebec. Snow lies on the ground from October till April but never to a depth of more than two or three feet. Temperatures somewhat below −40° F.

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[12] R. G. McConnell: Report on an Exploration in the Yukon and Mackenzie Basins, N. W. T., *Canada Geol. Survey Ann. Rept.*, Vol. 4 (N. S.), 1888–89, Part D.

[13] A. E. Cameron: Hay and Buffalo Rivers, Great Slave Lake, and Adjacent Country, *Canada Geol. Survey Summary Rept.*, 1921, Part B, p. 9.

have been recorded at Fort Resolution but are less extreme than at points on the prairies much farther south. Generally speaking, the winters are not more severe than in northern Ontario and, owing to the comparative infrequency of strong winds, are pleasanter. The western part of the lake ordinarily freezes in November, the eastern part a little earlier. The center of the western arm often remains free of ice till December, and McConnell reports that at a very deep point in the eastern part there is a channel open all winter. The ice leaves the western part of the lake in June, generally from the tenth to the twentieth. The eastern bays are not invariably clear for some weeks later. The delay in the departure of the ice in the eastern part of the lake, due in all probability mainly to a somewhat more severe climate, is, no doubt, accentuated by the absence of large rivers entering from the south, east of the mouth of the Taltson, and by the presence of numerous deep sheltered channels.

Forest and Swamp

The vegetation of the neighborhood of Great Slave Lake is essentially northern in character. The principal forest trees—white and black spruce, Banksian pine, tamarack, aspen, balsam poplar, and white birch—do not ordinarily attain the same size as in the valleys of the Slave River or the Hay River to the south or even on the islands of the southern part of the Mackenzie River to the west. In the rocky regions to the north and east, stands of even fair-sized trees are limited to sheltered valleys; the growth on the more exposed uplands is scant. The luxuriant vegetation in well protected ravines, even at the extreme eastern end of the lake, northern Canadian rather than Barren Land (Hudsonian) in character, suggests the existence of oases of milder climate; but the healthiness of the growth is due rather to shelter and good local drainage. The forest of the southwestern shores is more prolific, but it is open and parklike and not characterized by the thick, almost impenetrable undergrowth of the bush of northern Ontario or Quebec. The swamps in this southwestern section, probably on account of the relative dryness of the climate, lack the deep mossy surface characteristic of typical muskeg. The islands at the outlet of the Mackenzie and the neighboring mainland are reported "to exhibit a surface deposit of moss over ten feet thick." On the Department of the Interior map of Great Slave Lake (Western Sheet) the interior country near this part of the lake is said to be "low, swampy, and lightly timbered."

Game and Fur-Bearing Animals

The fauna of the region surrounding Great Slave Lake does not differ in any marked respect from that of northwestern Canada in general. It is evident, however, from a perusal of the records of the old explorers, that the diminution of large game and of fur-bearing animals has been progressive and rapid. In recent years this may be attributed to the keen competition of rival fur-trading establishments, to the increase of forest fires, to the introduction of white trappers, and more particularly to indiscriminate destruction by the aborigines since the general introduction of high-powered rifles. The moose deer was formerly common all around the shores of Great Slave Lake; it is now rarely seen. In Hearne's time the wood buffalo appears to have existed even on the eastern side of the Slave River, where that explorer left the lake in traveling south, and it also roamed the open country north of the outlet of the Mackenzie. It is now limited to the area north and east of the Caribou Mountains situated between Great Slave Lake and Peace River, where the authorities are now making determined and apparently successful efforts to protect it from the onslaught of hunters. Until twenty-five years ago, Barren Land caribou visited the eastern bays of Great Slave Lake in considerable herds in the annual migrations. Reports from old Hudson's Bay Company employees state that at a still earlier date they crossed the ice of the northern arm from the eastern side to the western in such numbers as to blacken the ice with a great moving mass which took days to pass. Now the hunters no longer find them on the shores of Great Slave Lake at any season of the year. They have to go farther and farther on the Barren Lands to the east before the herds are encountered. While the route of the migrations varies from year to year—a circumstance which leads to reports that the animals are disappearing—they are apparently still numerous, but they will not long remain so if the Indians are permitted to continue their methods of destruction. Apparently when a herd is encountered the killing does not cease until all available ammunition is exhausted.

Most, if not all, of the species of fur-bearing animals have become lamentably scarce. This may be in part due to the fact that the hare, on which a number of the other species feed, is passing through one of its periods of decline in numbers, owing to the ravages of the peculiar intermittent disease from which it suffers. It is said that the extermination of the fur-bearing animals is practically complete over considerable areas and that in certain sections one may travel fifty or sixty miles across the winter snow without seeing so much as the track of a single animal!

The Settlements

Fort Resolution and Fort Rae are the largest villages on Great Slave Lake. Fort Providence is situated on the Mackenzie River, a short distance below the lake. There are less important settlements at Fort Reliance at the eastern end; at Snowdrift, at the mouth of the river of the same name on the southeastern shore; at Yellowknife, situated near the point where the large river of similar name enters the northern arm; and at Hay River, on the southwestern shore. None of these communities has a permanent population of more than a few hundred. The inhabitants of the principal settlements consist mainly of European traders, missionaries, members of the Royal Canadian Police and a few other government officials, and the half-breed servants and associates of these individuals or organizations. At Fort Rae there are traders who are neither European, aboriginal, nor even Christian. They are Syrians—forming a remote outlier of Islam. Some of the half-breeds show by the fine old names they carry, and at times by an aristocratic bearing, that they are descendants of those romantic figures of the French régime, the *coureurs de bois*. The transient population at Fort Resolution and Hay River is swelled by the Indian children attending the missionary schools at these places, and at all the posts at certain seasons of the year by trappers, principally Indians, who resort there to trade and to enjoy for a brief spell the social amenities of the north. It is doubtful if the entire permanent population of the various posts amounts to five hundred.

The nomadic aboriginal population, trapping and fishing on the shores of the lake or in the region contiguous thereto, would not appear to number more than 1500 all told, and their number seems to be declining. Like all natives, they are subject to epidemics to which they succumb with a rapidity unknown in civilized communities. In the summer of 1928 an outbreak of influenza, in many cases followed by pneumonia, carried off 46 persons out of a total of 901 in the entire parish of Fort Resolution (which includes Yellowknife and other outlying communities), and, had it not been for the devotion of the Catholic priests and sisters, it is probable that the loss would have been much greater. The outbreak worked similar havoc at the other settlements. Another report is to the effect that twenty per cent of the native population died.

The aborigines belong to the Déné, or Athapascan, race, the variations of whose harsh guttural language may be heard throughout most of the valley of the great Mackenzie, among the Navajos and Apaches of Arizona and New Mexico, and among the Hupas of California. Around Great Slave Lake they are divided into three poorly defined tribes—the Slaves, living on either side of the western arm towards the outlet and extending down the Mackenzie; the Yellowknives, hunting around the river of the same name and near the eastern bays of the lake and trading at Fort Resolution; and the Dogribs, living between the northern arm and Great Bear Lake and trading at Fort Rae.

Petitot says that Great Slave Lake "doit ce nom à une tribu déné qu'y trouvèrent les premiers explorateurs, celle des Étcha Ottiné

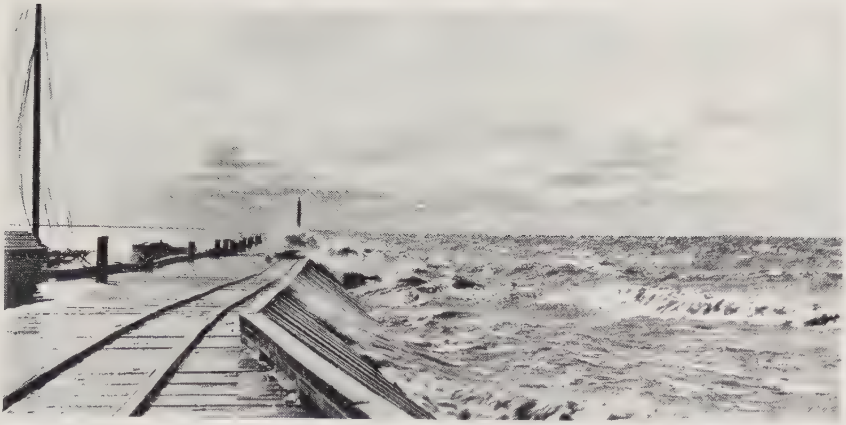

FIG. 2

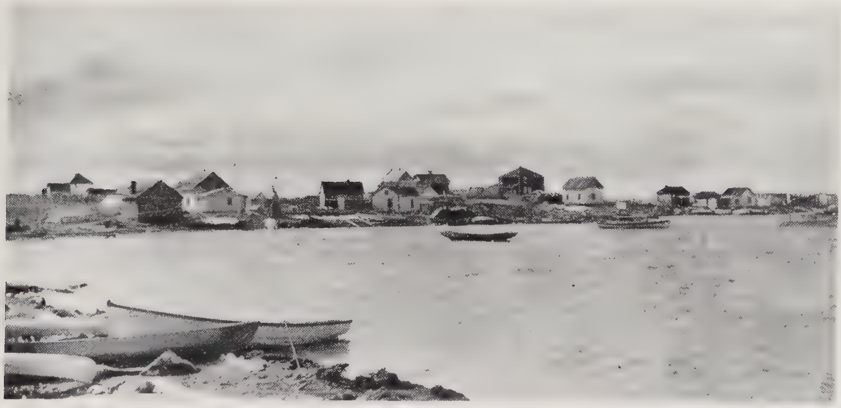

FIG. 3

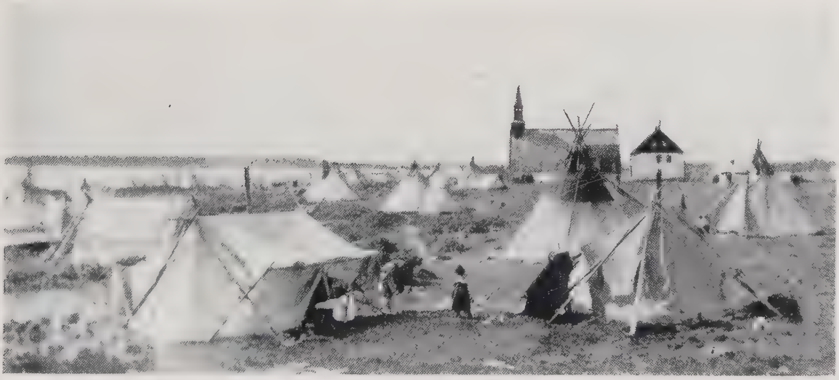

FIG. 4

FIG. 2—Great Slave Lake at Fort Resolution. (Photograph by G. M. Douglas.)
FIG. 3—Fort Resolution. Late summer. (Photograph by G. M. Douglas.)
FIG. 4—Indian encampment at Resolution waiting treaty payment. (Photographs 2 to 4 from the North West Territories and Yukon Branch, Canadian Department of the Interior.)

ou gens (vivants) à l'abri, sous-entendu des montagnes Rocheuses, Indiens dont les complaisances extrèmes et le servilité voisins de l'abjection leur valurent le nom d'Esclaves, tant des Anglais que des Français."[14] Mackenzie implies that the title of Slave was given to the Indians of this region as a term of reproach, rather than as a suggestion of servitude, by the Crees, who made frequent raids in days prior to the advent of the white man and who, being possessed of firearms, spread terror in the wake of their northern migrations.[15] Whether the origin of the name, Great Slave Lake, is reminiscent of the visits of these ancient warriors or is merely due to the character of the present inhabitants, the aborigines living in its vicinity have, in general, retained a servility, a feebleness, a meanness, an unreliability that entitles them all to the name borne by those dwelling near the western shores. Possessed of the truculence, the cruelty, the cunning of the Red Man, they lack the gaiety and consequent charm of the Eskimo, or the gallantry, constancy, and friendliness which the writer, at any rate, has observed among the Crees, Ojibways, and other Indian tribes of Algonquin stock. Commonly diseased, disliking the white man, whom, not unnaturally, they regard with suspicion as an intruder and the cause of the disappearance of the game, superstitious and pursuing a highly precarious existence, their life is drab, sordid, and singularly gloomy. But they are not devoid of good qualities; they are unusually patient under misfortune, possess remarkable endurance, and, though oversolicitous in their own behalf, are ready to treat hospitably those in distress, whether of their own race or not. Their legends indicate a sense of impish humor both childlike and engaging, while their conversation at times suggests poetic values which one would not ordinarily associate with so generally miserable a people. Warburton Pike relates a story of his faithful companion and guide, Saltatha, who, after listening to a disquisition by an old missionary on the merits of Heaven, replied, "My father, you have spoken well; you have told me that Heaven is very beautiful; tell me now one thing more. Is it more beautiful than the country of the musk-ox in summer, when sometimes the mist blows over the lakes, and sometimes the water is blue, and the loons cry very often? That is beautiful; and if Heaven is still more beautiful, my heart will be glad, and I shall be content to rest there till I am very old."[16]

Geology of the Region

With the exception of an inextensive outlier of Paleozoic rocks at the old site of Fort Rae, all of the eastern shore of the northern arm and the innumerable islands and shoals contiguous thereto are composed of Pre-Cambrian rocks. So also are the shores of the mainland and all the islands situated in the extensive part of the lake lying eastward of the northern arm on the north shore and of Stony Island on the south shore. Although the northern arm and the eastern bays of Great Slave Lake have been topographically surveyed, geologically considered the region is almost *terra incognita.* In 1899 a geological reconnaissance of portions of the eastern part was made by Robert Bell,[17] and in the same year work of a similar character was done by the writer, acting as his assistant, elsewhere in the eastern bays and along the eastern shore of the northern arm. In 1921 Hume[18] visited one of the principal islands in the center of the lake, variously known as Caribou Island, White Island, and Wilson Island. In 1922 and again in 1928 a little geological work under the direction of the writer was done on Les Iles au Large and near the mouth of the Yellowknife River. In 1928 also George Douglas, [19] assisted by C. Lausen,[20] conducted a geological investigation along the southern shore from the mouth of the Taltson River eastward and made several trips inland.

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[14] Petitot, Autour du Grand Lac des Esclaves, p. 74.

[15] Mackenzie, *op. cit.*, p. 3, footnote.

[16] Warburton Pike: The Barren Ground of Northern Canada, London, and New York, 1892, p. 276.

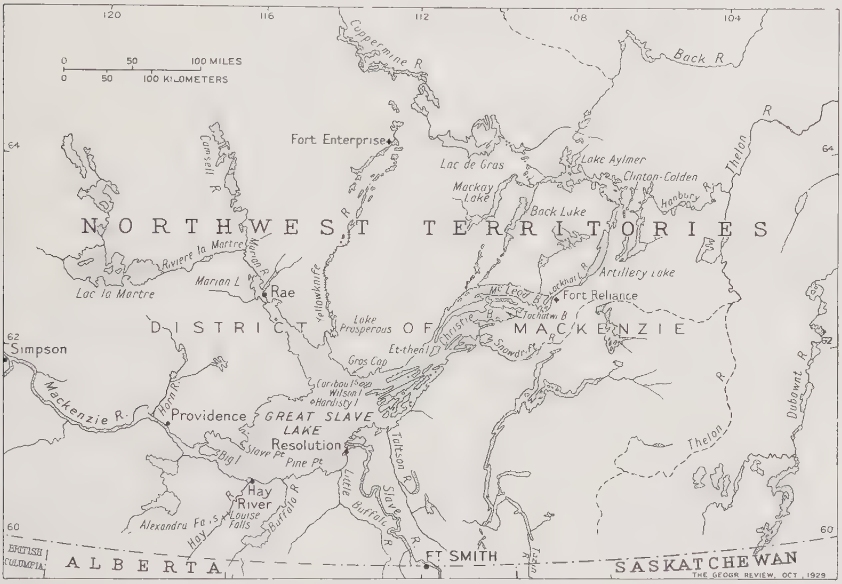

FIG. 5—Sketch map of Great Slave Lake. Scale approximately 1 : 9,000,000.

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[17] Robert Bell: *Canada Geol. Survey Ann. Rept.*, Vol. 12 (N. S.), 1899.

[18] G. S. Hume: *Canada Geol. Survey Summary Rept.*, 1929, Part B, p. 76.

[19] G. M. Douglas: A Summer Journey along the Southeast Shores of Great Slave Lake, *Canadian Mining and Metallurgical Bull.*, No. 202, February, 1929, pp. 344–360.

[20] Carl Lausen: A Geological Reconnaissance of the East End of Great Slave Lake, *ibid.*, pp. 361–392.

The whole of the western part of the basin of Great Slave Lake is underlain by Paleozoic rocks, which extend westerly from the western shore of the northern arm and from a short distance east of the mouth of the Slave River. The most easterly extension of the Paleozoic, that is the part contiguous to the Pre-Cambrian, consists of Ordovician-Silurian strata. Overlying these, westerly, come in succession the Middle Devonian and Upper Devonian. The superficial area over which the Ordovician-Silurian occurs is not great; these rocks occupy a narrow band striking approximately northwest along the western edge of the Pre-Cambrian.[21] The extension of the Middle Devonian is much greater. Outcrops of these rocks occur at intervals along the south shore of the western arm from near Fort Resolution to a short distance west of the mouth of the Buffalo and on the north shore from a short distance west of Hardisty Island to the foot of Deep Bay. Upper Devonian occurs at the extreme west of the lake and occupies a large area in the valley of the Mackenzie proper.

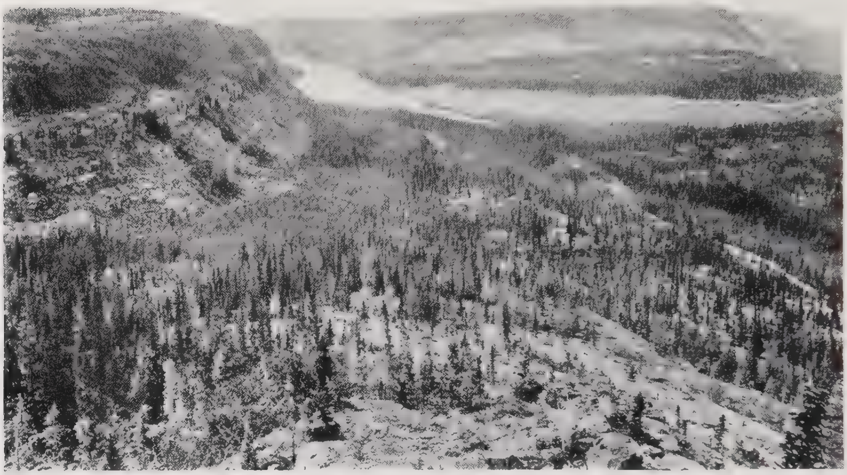

Fig. 6—The southern part of Kahochella Peninsula, eastern portion of Great Slave Lake, showing retreating escarpments of diabase (uppermost Pre-Cambrian) overlying limestone, which forms the gentle rock slopes. (Photograph by George Douglas.)

The Paleozoic rocks were deposited on the tilted edge of an ancient Pre-Silurian peneplain of Pre-Cambrian rocks and have a general westerly or southwesterly dip, forming a great monoclinal fold or possibly the easterly limb of a geosyncline. Suggestions of the westerly edge of this major structural trough appear on the eastern side of the Mackenzie in the vicinity of Fort Wrigley and elsewhere.

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[21] Cameron, *op. cit.*, p. 13.

The eastern shore line of the Paleozoic epicontinental sea was probably roughly parallel to the present boundary of the Pre-Cambrian. To what extent long-continued erosion has caused the edge of the Paleozoic to migrate westerly, it is impossible to say. As far as the northern arm is concerned, judging by the outlier at the old site of Fort Rae, it is probable that Paleozoic rocks originally extended at least as far as the eastern edge of this stretch of water.[22] The Paleozoics are in large measure shrouded by Quaternary material—glacial deposits and river and lake deposits. The thickness of the glacial deposits—stratified clays and boulder clays—appears to be very irregular. From such information as is available it would seem that the stratified clay is generally later than the boulder clay: the latter represents the ground moraine of the ice itself and the former deposits beneath the ice in its retreat or, more probably, in the greatly expanded lake near the retreating ice front.[23] The stratified clay may thus be regarded in part at least as transition material between the true glacial débris and the lacustrine beds of the later Quaternary. Moraines are fairly common but do not generally exercise much influence on the topography. McConnell indicates the existence of a prominent morainic ridge southwest of the western end of the lake, consisting of "a medley of steep-sided interlacing hills and ridges,

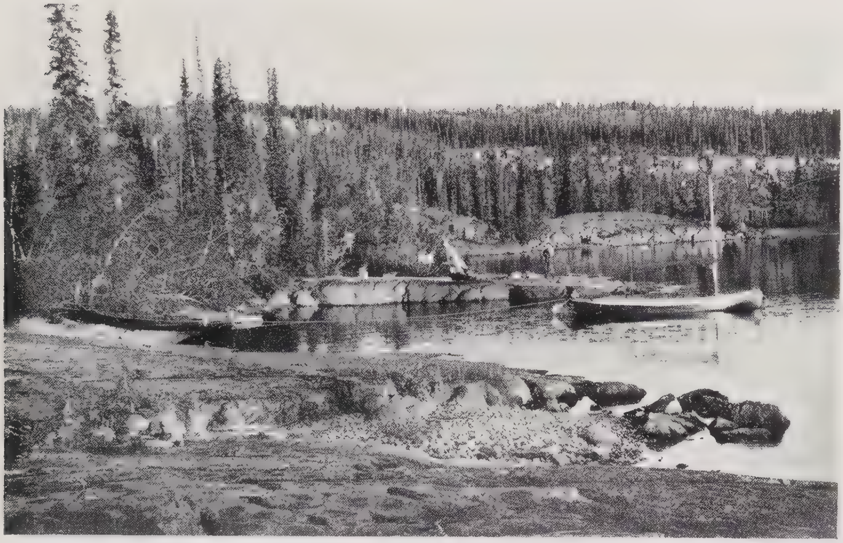

FIG. 7—A typical cove in Tochatwi Bay, eastern portion of Great Slave Lake. The photograph shows the flourishing vegetation where good shelter exists. (Photograph by George Douglas.)

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[22] D. B. Dowling: Geological Structure of the Mackenzie River Region, *Canada Geol. Survey Summary Rept.*, 1921, Part B, pp. 79–91; reference on p. 81.

[23] Charles Camsell and Wyatt Malcolm: The Mackenzie River Basin, *Canada Geol. Survey Memoir 108*, 1919, p. 82.

similar in appearance to those found on the Grand Côteau de Missouri of the plains."[24]

General Physical Features

For ease of description Great Slave Lake may be divided into four portions: the eastern portion, lying roughly easterly of a line connecting Gros Cap with the mouth of the Taltson River; the central portion, extending westerly to a line drawn from Hardisty Island to Fort Resolution; the westerly portion, continuing from this boundary to the mouth of the Mackenzie; and the northern portion, that part northward of a line drawn from Gros Cap to Hardisty Island.

Each of these divisions has distinctive physical features. The eastern portion, entirely within the area occupied by Pre-Cambrian rocks, has an extremely intricate shore line with a multiplicity of bays, sinuous channels, and innumerable islands varying in size from rocks a few feet in diameter to bodies of land many miles across. The western portion, within the Paleozoic strata, has a comparatively regular shore line with open bays and few islands. The central portion exemplifies the transition from the Pre-Cambrian to Paleozoic physiography with innumerable rocky islets to the east and a broad expanse of open water to the west. The northern portion, with Paleozoic rocks on the west and Pre-Cambrian on the east, partakes on the respective sides of a topography characteristic of the underlying rocks. It would be impossible to imagine a shore line more intricate than that to the east; the western margin is comparatively even and unindented. Lake Marian, which forms the northern extension of the northern arm, lying within Pre-Cambrian rocks, has a complex shore line.

Large as are the present dimensions of Great Slave Lake, the body of water which occupied the basin in the period immediately following the retreat of the continental ice sheet was even more imposing. A great arm stretched southward as far as the rapids on the Slave River at Fort Smith. Thence the southern shore line of the ancient lake trended northwestward, following probably the base of the escarpment which appears at intervals from the Salt River, a short distance west of Fort Smith, to the Hay River and probably farther. Many of the larger lakes to the south of the eastern portion of Great Slave Lake probably formed part of the original body. Though detailed information is not available, similarly it is believed that the whole of the original north shore line was very different from what it is today and that the ancient lake penetrated far to the northward. With isostatic readjustment after the departure of the ice sheet, the land rose and the lake boundaries gradually assumed their present general outline.

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[24] McConnell, *op. cit.*, p. 25.

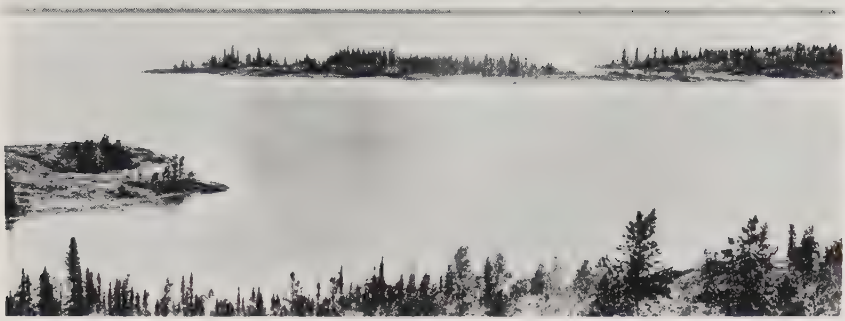

FIG. 8

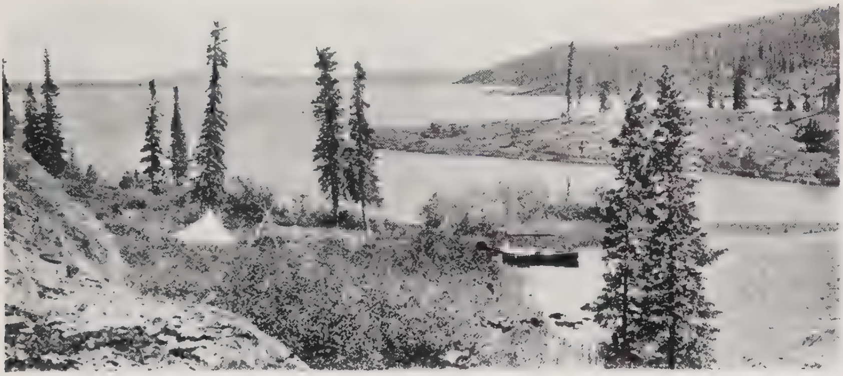

FIG. 9

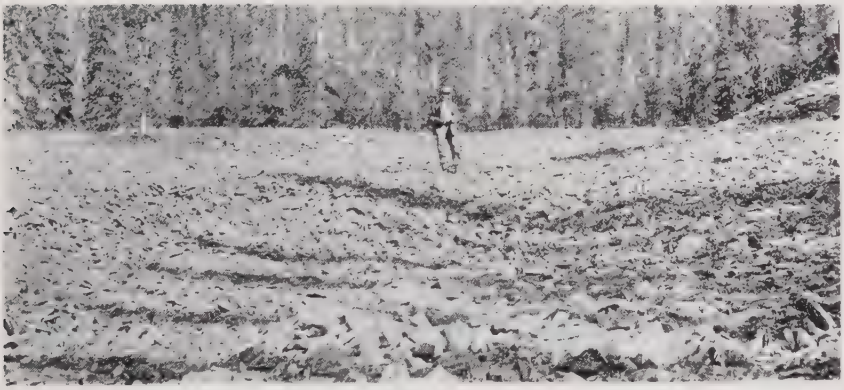

FIG. 10

FIG. 8—The Blessed Isles (so called because of the absence of flies) in Tochatwi Bay, eastern portion of Great Slave Lake. The islands are of sandstone. (Photograph by George Douglas.)

FIG. 9—A rendezvous much used by the Indians, Pekanatui Narrows in the eastern portion of Great Slave Lake. (Photograph by George Douglas.)

FIG. 10—An old shore line on the north shore of Tochatwi Bay. (Photograph by George Douglas.)

The Eastern Portion

The highest land in the vicinity of Great Slave Lake is at or near the eastern end. Here "an abrupt rise of about 600 feet" leads "to a rolling plateau." Kahochella Peninsula is described as being formed of a massive escarpment rising to 800 feet and "approached from the water by a long talus slope."[25] Sentinel Point on Kahochella Peninsula is said to rise fully 1000 feet above the lake.[26] On the northwest side of Pethei Peninsula are sheer cliffs rising 200 feet to 500 feet from the water. Similar declivities are visible at many other points towards the east of the lake, more especially on the islands. Some of the diabase sheets occurring here have produced, in their erosional retreat, a cuesta-like effect. While the summits of the hills and ridges on both islands and mainland are essentially bare and rugged, those on the mainland both north and south appear to have generally more gentle outlines than on the islands.

The maximum heights gradually diminish in passing from east to west. The greatest height near Gros Cap probably does not exceed 200 feet; and the highest land at the eastern end of the Caribou Islands, Wilson Island, and the Simpson Islands is no more elevated. From the highly indented shore line in the vicinity of Gros Cap there is a steep rise of about 175 feet from the wooded water's edge to an almost absolutely flat plain of bare granite, devoid of any depression of more than a few feet but lightly covered in places by caribou lichen, which sloughs off as one walks over its surface, or by a thin growth of peaty material.

The flat surface at Gros Cap is believed to represent the level of the ancient Laurentian peneplain tilted from east to west; as do also the ridges, of even sky line, increasing in elevation in the direction of the eastern end of the lake. This ancient peneplain, Pre-Ordovician in age, has been subjected to long-continued dissection, since the advance of the Paleozoic sea, by normal fluviatile activities modified by glacial agencies.

The whole topography of the eastern division of the lake, with strings of islands, prominent ridges, and dividing channels, all trending northeasterly, shows strongly the influence of the geological structure. Certain very straight, long, narrow, well defined channels, such as the one between the western end of Keith Island and the Simpson Islands, suggest fault lines. The intricate outline of this section of the lake, the innumerable bays and channels, the multiplicity of islands, all show the submergence of a former main valley opening to the west with many tributaries.

While Great Slave Lake has not been systematically sounded, it is probable that the deepest water is in the eastern portion, more especially far to the east where the silt from the Slave River is not transported. The bottom in this part of the lake is probably composed mainly of glacial material, upon which in passing westward an increasing amount of modern silt is deposited.

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[25] Eastern Sheet, Map of Great Slave Lake (1 : 380, 160), 2nd edit., Department of the Interior, 1925.

[26] Lausen, *op. cit.*, p. 366.

Old shore lines all around the eastern part of the lake testify to its former extent. In the vicinity of Fort Reliance and Pike's Portage extensive sandy terraces, on which are well marked old beaches, stretch back to the surrounding hills. Fine examples of elevated beaches show along the north shore near Taltheilei Narrows.

All of the rivers flowing into the eastern part of the lake are characterized by numerous waterfalls; and some of those entering on the north shore, are unnavigable near their mouths owing to the series of rapids and falls by which they descend from the interior plateau. Lockhart River descends fully 400 feet in the twenty miles or so of its course from Artillery Lake to Charlton Bay (east part of McLeod Bay). Pike's Portage route—a chain of small lakes—is used by travelers to circumnavigate this stretch of broken water. The Hoarfrost River, which was followed by Back to its source in Walmsley Lake, has a very steep gradient. At its mouth there is a fall of 60 feet.

The two principal rivers of the south shore, the Snowdrift and the Taltson, though broken by rapids and falls, are of more gradual descent. George Douglas, in a personal communication to the writer, reports a waterfall of considerable height near the mouth of the Laloche River. The lower reaches of the Taltson come within the influence of the topography of the Slave River delta, as is testified by the low cliffs of silt near the mouth and the multiple stream channels flowing with even current.

The Central Portion

The central portion of Great Slave Lake is the remnant of what was formerly the main division stretching southward as far as the rapids of Fort Smith. Its present southern boundary from the Taltson River to Fort Resolution is formed by the delta of Slave River, which is constantly spreading northward. The Slave River at this point, nearly 1400 miles from its source at the head of Peace River, is a mighty stream bringing down vast quantities of silt in suspension and during high floods large amounts of driftwood. Much of the latter, especially the larger tree trunks, becomes stranded close to the numerous mouths of the Slave to form the nuclei of new bars and islands and thus accelerate alluviation. The courses of the river channels, ramifying through the shelf of shallow water extending far outward from the shore, are constantly changing. The shore itself, being composed of new land, is low and marshy; farther inland willows appear; relatively older land is clad in cottonwoods; while where spruce forest is found at some miles from the present shore there is evidence of well established drainage.

In the eastern part of the central division of the lake are numerous groups of islands, Les Iles Basses, Les Iles au Large, Les Iles du Galet, and others. These represent the unsubmerged remnants of the ridges of the westerly pitching peneplain of Pre-Cambrian rocks. Around all of them are many shoals, rising but a few feet above the muddy lake bottom. The depth of the water in the central portion increases northerly towards the northern arm. It has not been sounded but is believed to be of no great depth at any point. It is nowhere free of silt but becomes clearer as the distance from the Slave River increases.

The islands are all small and low. The well glaciated elongated ridges on the larger ones are separated by narrow valleys filled with talus or glacial débris covered by peaty soil, supporting generally a scant vegetation but in places where local drainage is good a fair growth of trees. Stony Island, forming one end of long traverses to various points to the east and north of the lake, has consequently been visited by many travelers, who have reached its rather gloomy shores with a feeling of happiness after tempestuous journeys.

The Western Portion

The western division of Great Slave Lake, surrounded by generally low shores and filled with muddy water, entirely lacks the scenic charm of the eastern portion.

At Resolution a low range of hills appears above the silts of the Slave River delta and extends west into the lake, forming Mission Island. Similar ridges, reaching a maximum height of possibly 100 feet above the water, show along the south shore, at the mouth of the Little Buffalo River, near Pine Point, and at High Point. Higher ridges, reaching probably 250 feet in height but with slopes generally so gradual as to be scarcely perceptible, strike roughly parallel to the shore a few miles inland from Pine Point.

West of the mouth of the Hay River on the south shore and of Slave Point on the north shore the lake is bordered by low-lying swampy country. This low land is said to stretch for an unknown distance northward, while southward it is bounded by the Eagle Mountains, an escarpment rising 300 or 400 feet above the Mackenzie.[27] The dreary topography of the north shore from Slave Point northeastward towards Hardisty Island is but slightly relieved by numerous long, narrow ridges rising 100 to 150 feet above the lake

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[27] E. J. Whittaker: Mackenzie River District Between Great Slave Lake and Simpson, *Canada Geol. Survey Summary Rept.*, 1921, Part B, pp. 45–55; reference on p. 47.

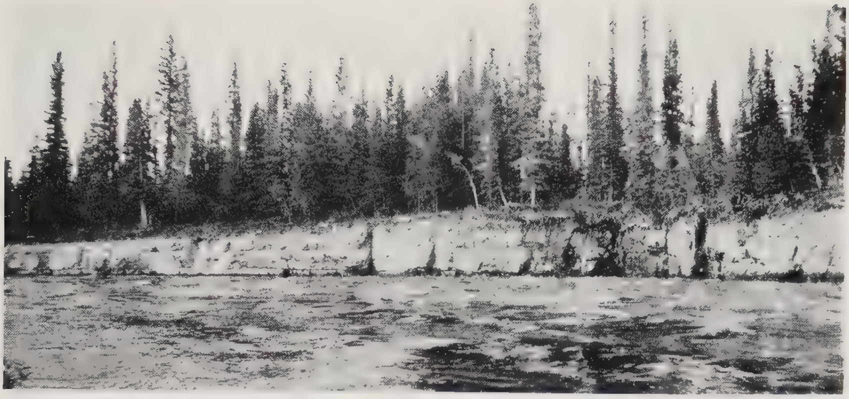

FIG. 11

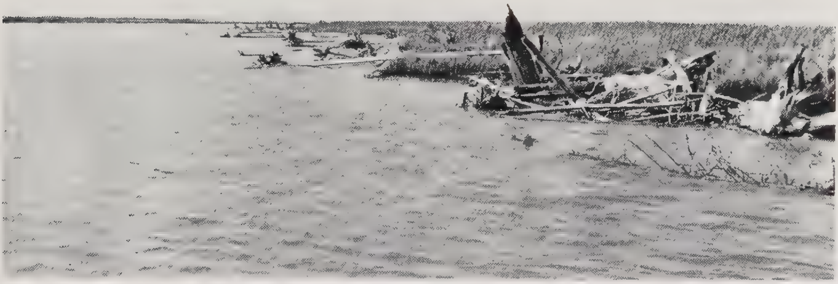

FIG. 12

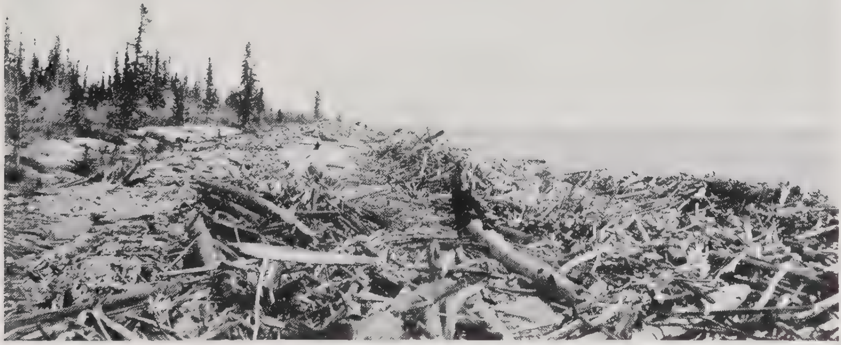

FIG. 13

FIG. 11—The limestone ramparts at Mellor Rapids, Buffalo River. (Photograph from Canadian Geological Survey.)

FIG. 12—Typical shore line of the delta of the Slave River, Great Slave Lake. The stranded tree trunks brought down by the river may be observed. (Photograph by George Douglas.)

FIG. 13—Driftwood on the southern shore of Great Slave Lake, east of the Slave River. (Photograph from Canadian Geological Survey.)

level and showing in many places, "low wave-cut cliffs facing lakewards, at elevations above the present lake-level."[28] Above and below the cliffs are numerous old lake beaches.

A few low-lying islands of limestone, strewn with Pre-Cambrian boulders and generally well wooded, divide Resolution Bay from the open waters of the lake. A number of low, swampy islands, the chief of which is Big Island, mask the entrance to the Mackenzie. Similar low islands are inconspicuous features along the north shore. The south shore is devoid of pronounced embayments; the north shore is indented by many deep, narrow, shallow bays, ending in marshes or in sloughs.

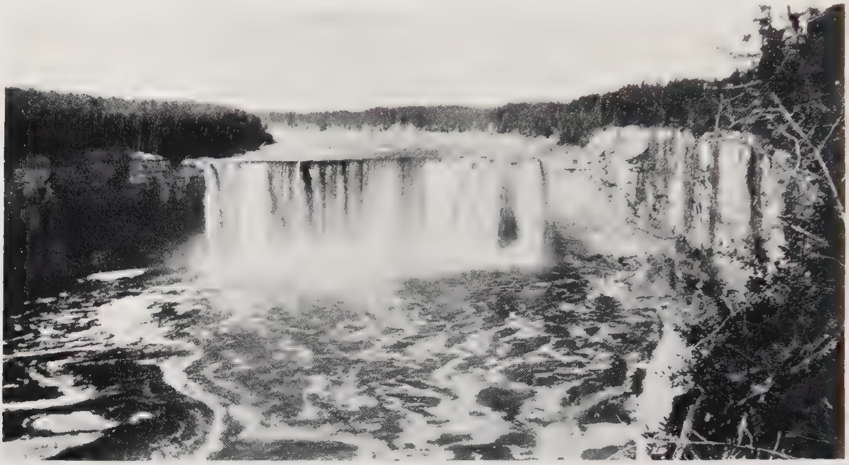

FIG. 14—Alexandra Falls on the Hay River. The falls have a drop of 105 feet over limestone underlain by shale (Upper Devonian) and resemble Niagara in structure. (Photograph from Canadian Geological Survey.)

The water of the western arm is generally shallow: in many places it is difficult to approach the shore of the mainland even with small boats. The open bays of the south shore are ordinarily bordered by gravelly beaches strewn with immense quantities of driftwood and overlying low, shelving outcrops of solid rock. Large glacial boulders are scattered along these beaches and over the adjacent lake bottom, forming in the murky water a menace to navigation. Behind the gravelly beaches, narrow lagoons or swampy stretches are of common occurrence, paralleling the shore line. Inland from Pine Point are well developed old gravel beaches which, extending in long curves, tend to follow the gentle sinuosities of the existing shore line.

In regard to the portion of the lake west of the mouth of the Hay River and Slave Point, Cameron says, "This part of the lake is very shallow and the shoreline in most places is formed of boulder pavements embedded in a soft blue-to-grey clay. Short, narrow points, formed of boulders derived from the Precambrian rocks east of the lake are very numerous, particularly in the deep bay north of the outlet, and boulder reefs occur at long distances from the shore. All the points have a tendency to parallel the direction of glacial movement"[29] (N. 85° W. astronomical). The outlet of the Mackenzie is at times so shallow as to affect the passage of the river steamers.

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[28] Cameron, *op. cit.*, p. 11.

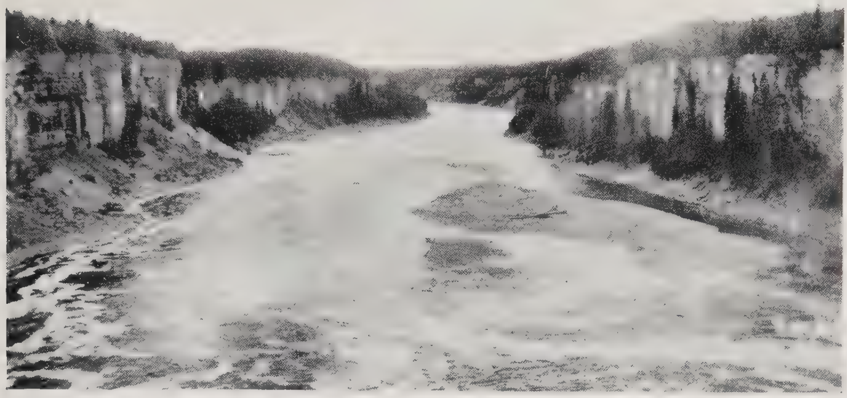

FIG. 15—The gorge between the Alexandra and Louise Falls, Hay River. The structure is similar to the Niagara gorge below Niagara Falls. (Photograph from Canadian Geological Survey.)

An extraordinary feature of the north shore of the western portion of Great Slave Lake is the absence of any entering streams of appreciable size. Little Buffalo River, Buffalo River, and Hay River flow into the lake from the south. The Little Buffalo rises in the eastern slopes of the Caribou Mountains and thence flows northeasterly to a point about 20 miles west of Fort Smith where it drops over the northern edge of the Alberta escarpment.[30] Thence its unbroken course closely parallels that of Slave River, from a few miles to a maximum distance of 25 miles to the east.

Buffalo River rises in Buffalo Lake, into which a number of small streams flow from the slopes of the Caribou Mountains. From Buffalo Lake to Great Slave Lake—a distance of 75 miles—rapids occur at a number of points, the principal being at about 20 miles above the mouth, where the river passes through a limestone gorge.

Hay River is a more important stream than either the Little Buffalo or the Buffalo. It is said to be 300 miles in length and to rise near the headwaters of Fort Nelson River. From 20 to 22 miles in a straight line from Great Slave Lake, Hay River precipitates itself over the edge of a pronounced escarpment, forming two falls about a mile and a half apart. At the upper of these, Alexandra Falls, there is a vertical drop of 100 feet. The lower, known as Louise Falls, have a total drop of 45 feet in a series of steplike chutes. Below the lower falls, the water flows through a gorge about five miles in length, the upper three miles being rapid water. While both falls are beautiful, Alexandra Falls are especially so. They form a veritable scenic gem in the midst of a vigorous spruce forest. A miniature Niagara in form, they bear another resemblance to the great cataract. The rate and extent of recession from the face of the escarpment to which they owe their origin, by a coincidence, has been about the same since glacial times.[31]

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[29] *Ibid.*, p. 10.

[30] Camsell and Malcolm, *op. cit.*, p. 28.

The Northern Portion

Excavated along the line of contact between the Pre-Cambrian and the Paleozoic rocks, the northern arm of Great Slave Lake shares the topographical peculiarities of both rocks. The topography of the east shore of the northern arm, apart from the vicinity of Yellowknife River, and that of Lake Marian lack the northeasterly trend characteristic of the eastern portion of Great Slave Lake, owing to the fact that most of the rocks are massive rather than bedded or sheared. Generally speaking, the country may be described as rough, broken, and irregular. The highest points are isolated rounded knobs, rather than well defined ridges. The most conspicuous hill in the country around Lake Marian is on its west shore; it reaches a height of perhaps 300 feet.

From the outlet of Lake Marian, which discharges into the northern arm by a number of short ramifying channels, to Gros Cap, the country is devoid of pronounced relief; close to the east shore there are few hills which exceed 125 feet in height. One of the most conspicuous elevations, strangely enough, is the isolated bluff of Paleozoic rocks at the old site of Fort Rae. This is a flat-topped butte about 100 feet high, situated near the end of a long point and separated from the low mammillated Pre-Cambrian hummocks to the east by a swampy isthmus elevated but a few feet above the water.

Yellowknife Bay, which forms the mouth of the river of the same name, penetrates eastward about ten miles from the main part of the northern arm, and the valley of the lower part of the river itself is eroded along a narrow trough of bedded and foliated rocks, producing a topography differing to some extent from that prevailing elsewhere along the eastern side of the northern arm. Ridges, generally short and hummocky but elsewhere elongated and possessing an even sky line, rise to 200 or 250 feet above Great Slave Lake. A

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[31] A. E. Cameron: Post-Glacial Lakes in the Mackenzie River Basin, North West Territories, Canada, *Journ. of Geol.*, Vol. 30, 1922, pp. 337–353; reference on p. 353.

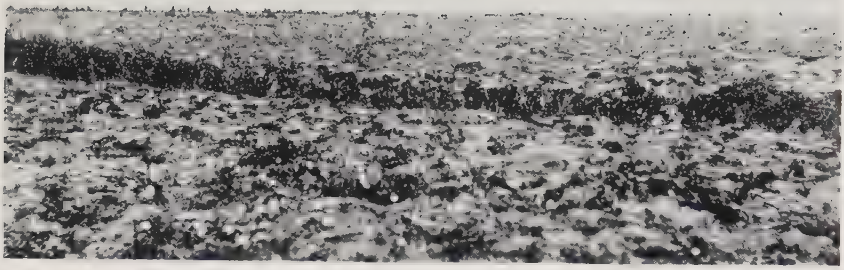

FIG. 16

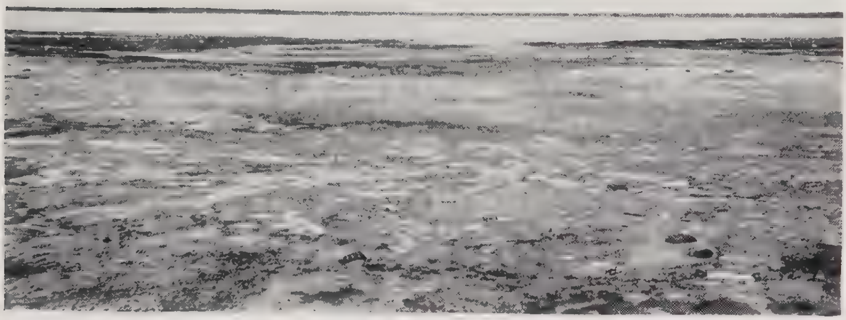

FIG. 17

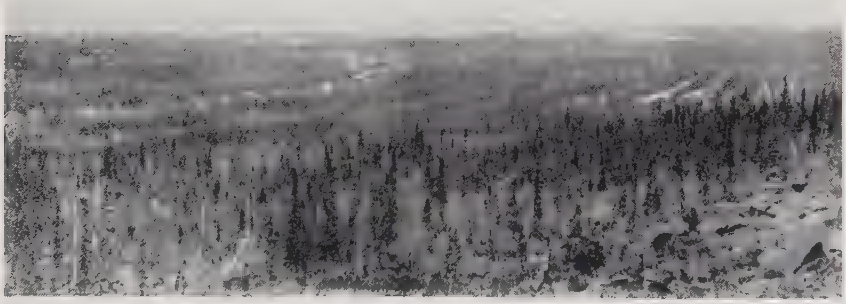

FIG. 18

FIG. 16—The flat, almost treeless plateau on the top of the Horn Mountains—a low elevation of limestone, northwest of the western portion of Great Slave Lake. The surface is typical muskeg. (Photograph from Canadian Geological Survey.)

FIG. 17—Sulphur and calcareous deposits at Sulphur Bay on the northwestern shore of the western portion of Great Slave Lake. (Photograph from Canadian Geological Survey.)

FIG. 18—Raised beaches at Le Gros Pointe, north arm of Great Slave Lake. (Photograph from Canadian Geological Survey.)

view from the top of any of these greater elevations discloses typical Laurentian scenery not unlike that of northern Manitoba or the rockier parts of northern Ontario—ridge upon ridge of bare or nearly bare rock separated by depressions, in places filled with scrubby timber, elsewhere occupied by clear-watered lakes of every size from mere ponds to bodies of water five or six miles or more in length. The open valley of the Yellowknife, famed as the route followed by Franklin—now constricted and occupied by stretches of narrow river, again widening and filled with considerable lakes—can be traced for miles till it disappears in the hilly country to the north.

From one of the highest hills on the western side of Lake Marian the low flat-topped ridge forming the edge of the Paleozoic rocks can be observed trending off northwestward, parallel to the valley of Marian River. Southeastward this ridge merges in the slightly elevated country forming the western border of the northern arm. While there are no conspicuous heights close to this shore, the country for the most part rises 100 feet or slightly more above the lake a short distance back from the water. Opposite Yellowknife Bay are extensive ridges of coarse sand, exhibiting the usual bizarre forms of moving dunes.

The water of the northern arm is shallow and generally fairly clear, excepting when strong winds blow from the south, but not of the limpidity of the eastern bays. Navigation is both difficult and dangerous on account of the large number and wide distribution of submerged rocks, many of them uncharted.

It requires the knowledge of a native of the northern arm to follow the sinuosities of its shore line. A mainland indented by innumerable bays is masked by such a mass of islands that it is often impossible to say whether one is actually thereon or merely on one of the islands separated from it by narrow channels generally shallow and marshy. Farther offshore is a veritable maze of islands rising a few feet above the water, with shoals whose location is commonly only apparent in stormy weather. Towards the points, the shores of the bays are generally of solid rock, often extraordinarily ice-polished. Elsewhere they are in places swampy or bordered by old beaches. The lake bottom is commonly composed of very sticky gray clay resembling rock flour. This is evidently the finest material brought down by Slave River and carried farthest in suspension.

In contrast to the opposite side of the northern arm, the western shore line is, relatively speaking, even and unindented. There are numerous bays, but they are broad and open; there are comparatively few islands, and the unquestioned mainland is plainly distinguishable from the open water. Low cliffs of Paleozoic rocks, wave-cut, appear in places close to the points. The bottoms of the bays tend to terminate in swamps or are extended inland in marshy lagoons.

Apart from Yellowknife River the most important stream entering the northern arm is the Marian, flowing into the northern end of the lake of the same name. The Marian drains a chain of large lakes forming part of the canoe route to Great Bear Lake, which closely follows the Paleozoic-Pre-Cambrian contact.

Origin of the Basin

While the coming into existence of Great Slave Lake is a recent geological event and is due primarily to interference with the conditions of drainage existing before the glacial age, the peculiarities of the outline of the basin, as also of many of the characteristic topographic forms, are due in part to causes much more ancient. Structure has had a decided effect in shaping many of the physical features of both land and water. Preglacial subaerial erosional sculpturing was the basis of relatively speaking minor glacial excavation.

In Pre-Ordovician times, the Pre-Cambrian rocks of Canada were very widely base-leveled by subaerial agencies. The surface upon which rose in turn the Ordovician-Silurian, Middle Devonian, Upper Devonian, and possibly later seas over what is now the western part of Great Slave Lake was of extremely low relief with only minor irregularities.[32] As the weight of sediments grew and the surface of the peneplain was tilted upward towards the east, renewed dissection of the land began. Prior to or concurrent with the Rocky Mountain folding the sea to the westward disappeared, and this newer land also came under the influence of subaerial attack.

By the period immediately preceding the advance of the Keewatin ice sheet, drainage was well established and, in much of what is now the basin of Great Slave Lake, was probably mature. It is difficult to establish assuredly the courses of even the larger preglacial streams, but many features suggest that a great river flowed northward close to the border of the Paleozoic and Pre-Cambrian rocks along or near the present valley of the Slave. While proof is lacking, there are certainly topographical reasons for believing that this preglacial river, instead of following the present course of the Mackenzie, may have continued northward along the contact as far at least as Great Bear Lake. Into this river from the west would have flowed the antecedent of Hay River with minor tributaries, and from the east a large stream formed by the union of a number of ramifying branches.

The nature of the sculpturing done by these preglacial streams would depend on the structure and the lithology of the underlying rocks, but even in the Pre-Cambrian it may be assumed there were broad basins—the result of long-continued erosion. Into this well dissected region, with narrow ravines opening into broader depressions and these in turn into spacious valleys, advanced from the east the Keewatin ice sheet. The record of its handiwork shows today in disorganized drainage and modified land forms.

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[32] Compare the Lake Athabaska region. See F. J. Alcock: The Origin of Lake Athabaska, *Geogr. Rev.*, Vol. 10, 1920, pp. 400–407; especially p. 404.

It is not the intention of this article to enter into the controversial subject of the extent of erosion by the Pleistocene glaciers. There is abundant evidence that the ice not only shifted vast quantities of detrital material but, after removing the products of decomposition, polished and striated even the hardest rocks below, as is so well shown around Great Slave Lake. Thus, apart from actual removal of solid rock, the glaciers are believed to have gouged and deepened the aggraded valleys. Erosion of solid rock was probably selective. Softer or shattered material along fault planes or highly schisted shear zones would be susceptible to furrowing; the ridges of well jointed rocks to plucking. If the extent of erosion of solid rock were uniform it is difficult to explain how a mass of soft limestone, like the butte at the old site of Fort Rae, could have resisted the attack which has polished to the smoothness of glass the granitic rocks a short distance away. While there is no information available for gauging the extent of removal of solid rock by the ice, it may be assumed that the preglacial valleys, situated where the basin of Great Slave Lake now lies, were in many cases both widened and deepened.

Cameron, in his paper "Post-Glacial Lakes in the Mackenzie River Basin," has graphically described the progressive stages passed through by Athabaska and Great Slave Lake as the Keewatin ice sheet slowly withdrew to the eastward. The water of Great Slave Lake, impounded between the morainic material flung across the valley of the Mackenzie near the lake's present outlet and the retreating ice, rose until it flowed over the dam to the west or was captured by the advance of a tributary of the Mackenzie. In the first instance the presence of the ice and at a later period morainic dams would have prevented the reëstablishment of the presumed northerly drainage along the depression following the Pre-Cambrian-Paleozoic contact until the present outlet was well established.

Cameron, largely on the evidence of numerous closely spaced old beaches, believes that the differential postglacial elevation to the east and west of Great Slave Lake has had the effect of rapidly draining the great basin in the past and concludes that the movement is still in progress, as would appear from the beach lines built up in modern times. Meanwhile the rapid alluviation by the silt brought down Slave River proceeds—carrying the delta farther and farther into the central portion of the lake and distributing fine material almost to its remotest bays. The great lake is doomed to follow in the wake of other greater postglacial features and disappear or dwindle into insignificance.

AGRICULTURE AND SOILS OF PALESTINE

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U. S. Department of Agriculture

WHILE there is probably no other country in the world that has been so thoroughly studied from archeological and historical viewpoints as Palestine, it is certain that in none of the civilized countries has there been such a complete neglect of subjects pertaining to agriculture.

Geological investigations indicate the practical absence of mineral wealth. A potential supply of potash and other salts in the water of the Dead Sea, together with small quantities of phosphate rock, sulphur, and bitumen, seems to cover the field of mineral resources. With the establishment of stable governments throughout Asia Minor, Palestine will derive material benefit from the development of commerce, a large part of which will doubtless cross the northern part of the country, en route to the port of Haifa on the Mediterranean coast. This prospective development will affect mainly the larger towns, contributing but little to the upbuilding of the remainder of the country. Practically devoid of mineral wealth, having no forests, and but limited possibilities for the development of hydro-electric power, Palestine must look, for any substantial increase in wealth and prosperity, to the development of her agriculture.

Palestine is not self-supporting with respect to her major food products, and only a few fruits and vegetables are produced in excess of local consumption. A study of the data presented in the Annual Report of the Department of Agriculture, Forests, and Fisheries for 1926[1] shows that the value of imports of all agricultural products exceeded the value of exported products by £E210,305 (£E = $5.00). If fruits and vegetables are excluded from the total, there was a net excess of £E618,587 of imports over exports. The condition of the world market will affect Palestine's balance of trade to some extent, but, until the country produces the greater part of her food supply, economic conditions will remain unsatisfactory. Agricultural land is the most important natural resource. It is vitally important that the character and distribution of the soils be ascertained and that the best methods of handling them, according to their specific adaptations and requirements, be determined and put into practice.

The beginning of agriculture in Palestine goes far back beyond the

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[1] Annual Report, Department of Agriculture, Forests, and Fisheries, October 1, 1925, to September 30, 1926. Jerusalem.

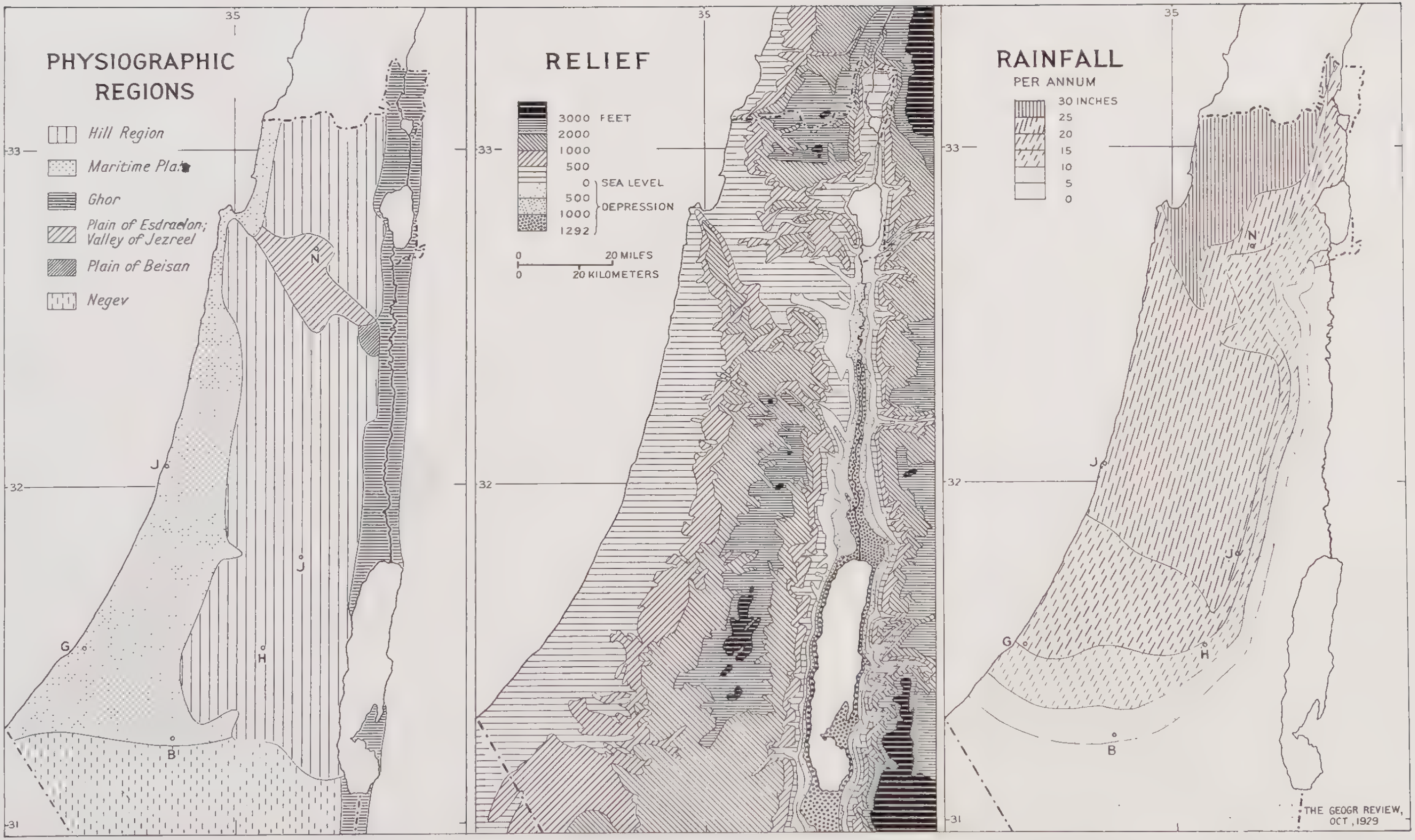

FIG. 1 Physiography, relief, and mean annual rainfall of Palestine, exclusive of the area of the Negev from latitude 31° S. to the Gulf of Akaba, a desert region, on which little information is available. Scale approximately 1 : 2,500,000. Compare Figure 4.

dawn of recorded history. The first records of invasion show that agriculture then was not greatly different from what it is today. The hills, although considerably better covered with forest trees than now, supported a fairly dense population that grew cereals, fruits, and olives over an area that was at least equal to that now under cultivation. In the Jordan Valley, irrigation works going back into remote antiquity indicate a far more extensive use of the land in those times than in recent centuries. History records the existence of date gardens, fields of sugar cane and cotton, and of a wide variety of tropical and semitropical fruits.

Numerous wars throughout the centuries resulted in a depletion of the population and the subsequent reversion of the land to something like its original condition or in the actual disappearance of cultivated areas by destruction of hillside terraces. Although Palestine has not suffered greatly from war for a long period now, she has been under the rule of aliens who have had but little concern for her material welfare, and the rural population has struggled along under conditions discouraging to any initiative. It is probable that the agriculture of Palestine was never at such a low ebb as at the close of the World War.

The present-day agriculture is that of cereal farming and "plantations," the term "plantation" being applied almost wholly to plantings of fruits and nuts, although it sometimes includes vineyards. The production of cereal crops is largely monopolized by Arab farmers, while both Arabs and Jews are engaged in fruit-growing. The production of vegetables is an industry of considerable magnitude in which all races are engaged, with the Arab farmer predominating.

Aside from a few localities where irrigation made possible the growing of any crop desired, there was, up to about the time of the World War, practically no recognized adaptation of crops to soils. Instead, centers around which definite types of agriculture developed were more or less unconscious responses to differences in rainfall. Barley, for instance, because of its ability to mature under conditions of lower rainfall than wheat, is largely grown in the region east of Gaza. Sesame is grown most extensively in the northern part of Palestine, where the average rainfall is 25 inches or more, and Indian corn (maize) appears in regions of similar rainfall. Olives, although grown throughout the length of the land, produce profitable yields with a rainfall of 20 inches or more, and the most thrifty groves occur in the hills of northern Galilee under a rainfall of 30 or more inches.

Since the establishment of the present government, extensive agricultural developments have followed in several districts, accompanying the employment of scientists trained in different branches of agriculture. The general adaptations of the principal families of plants to broadly defined soil conditions is well known and, to that extent, the general distribution of crops for the soils of the country can be worked out. With few exceptions, however, but little is yet known regarding the specific soil requirements of different varieties of the same crop, and the working out of a variety distribution is a task calling for a long period of study and investigation. The consideration of the use of the soils involves a recognition of the fact that the larger part of the crops must always be grown under low rainfall conditions and without irrigation.

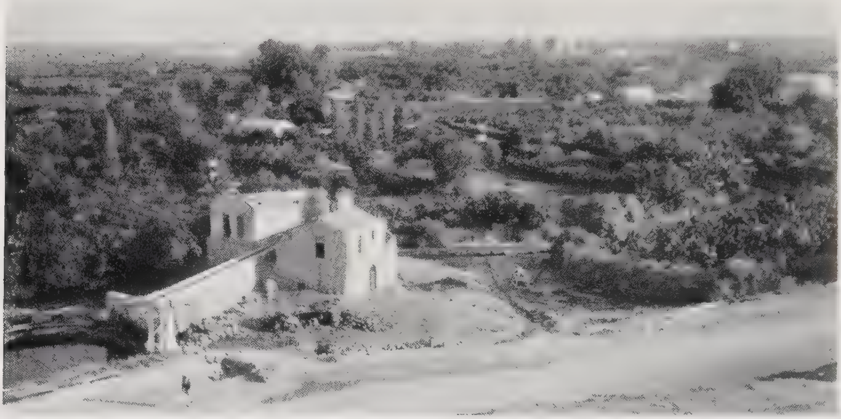

FIG. 2—View from the tel of old Jericho, showing pool formed by large spring in foreground and irrigated area around the present town of Jericho, growing tropical and subtropical fruits and vegetables. Bananas are one of the principal fruits.

Throughout the hill regions cultivated areas are mainly adjacent to the villages, and the distribution of crops is more largely governed by topography than by character of soil. There is, also, a tendency among the communities to favor some one crop, although practically all varieties grown in the hills will be found to some extent in every district. Grain production is confined almost wholly to areas where cultivation is possible without resorting to terracing: grapes come largely from Hebron, apricots and peaches from the district between Bethlehem and Hebron; olives from Beit Jala, Ramah, Nablus, and from the north and west of Nazareth. The vegetable gardens of Ram Allah cover hundreds of acres, the country around Geba is noted for its figs, and pomegranates thrive in the region of Kfar Kanna, northeast of Nazareth.

The extent to which the Judean Hills and portions of the Samarian Hills have been used for cultivation, both in the past and present, is remarkable. A crop will be found growing during every season of the year wherever the soil is not too stony, nor the slope too steep for the native to use his wooden plow. Little plots of ground, of only a few hundred square feet in area, have been searched out, and the winter and spring months find the steep hillsides dotted with grainfields of every conceivable shape and size.

When the population of the hills reached a density that compelled the utilization of slopes too steep for the usual methods of cultivation, terracing was resorted to, and the former extent of the terraces points conclusively to a period when the hills supported a rural population considerably in excess of that of the present. Thousands of acres of the stone-walled terraces on the Judean Hills have fallen into decay or largely disappeared. With one exception, no evidence of an extension of the present terraced area has been noted, even in a few localities where it might be possible to construct new ones, and it seems probable that a rough balance has been established between the area of cultivated terraces and the number of persons available for their maintenance and cultivation. The residual soil of the hard limestone regions is very susceptible of erosion when not protected by natural vegetation or by artificial works; and, with the loss of the retaining walls, the soil is carried into the wadies, and the area that was once under cultivation can never be regained. In the Samarian Hills the soils are extremely resistant to erosion, and steep terrace slopes will stand indefinitely with only a protective cover of weeds and grasses.

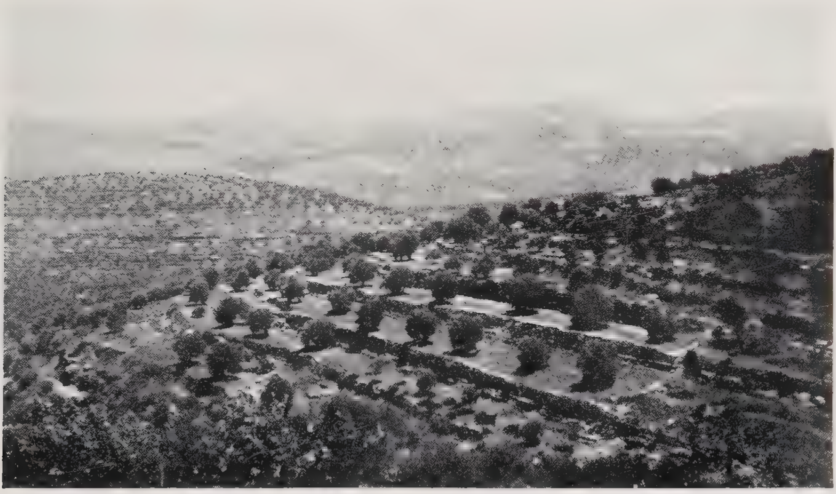

FIG. 3—Terraced olive groves west of Jerusalem. Note the stone retaining walls to hold the easily eroded soil of these Judean Hills. Compare Figure 5.

Within the hill regions agriculture may not be expected to show any marked departure from that of the present in the matter of the varieties of crops, although a considerable improvement in yields and quality of fruits and vegetables should follow as it becomes possible to reach the native farmer with a campaign of education.

Throughout the lowlands of the country practically every acre of tillable land is used for some crop, cereals being the mainstay with lesser areas devoted to fruits and vegetables. For untold centuries the soil has been scarcely scratched by the wooden plow; each year's stubble is grazed to the very surface of the ground by successive herds of goats and camels, and nothing has been returned to the soil in the way of manures and fertilizers. As a result, the average yield of wheat in Palestine has fallen to a little less than nine bushels an acre, and that of barley to less than five bushels. Were it not for the fact that, other than for a possible outlay for seed, the prices received by the native farmer are practically all profit, not even he would be able to maintain an existence.

Experience shows that greatly increased yields are possible with thorough tillage and with the returning to the soil of organic matter either in the form of plant residues or stable manures. In the older German colonies, established more than a quarter of a century ago, such practices have raised the average production of wheat to as high as 20 bushels an acre, barley to 40 bushels; and the yields continue to show slow increases from year to year. In the more recently organized Jewish colonies,[2] where the soil has had but a few years of proper treatment and where conditions have often been none too favorable, the average yield of wheat has been brought to a little more than 11 bushels, individual fields have returned as high as 20 bushels, and the Arab's return of 5 bushels of barley to the acre has been exceeded by nearly fourfold.

Owing to the scarcity of water for irrigation, dry-farmed crops will continue to occupy the greater part of the tillable land of the plains and valleys; and, as the small grains can grow throughout the rainy winter and mature in the early summer, cereals will continue to be the principal crop. Vineyards and almonds have proved successful without irrigation; but their distribution is limited by certain soil conditions, and the acreage of those crops will be restricted to a number of well known districts. The native farmer can continue to exist upon the yields he ordinarily secures from his dry-farmed crops, as his cost of production is low and his living of the simplest. In the production of such crops the outsider cannot compete, since his cost of production usually exceeds his returns. The production of cereal crops is, however, necessary; and, if the Jewish colonist is to maintain his hold on the land, living returns must be assured by the adoption of a plan of general farming that will include the production of forage crops,[3] vegetables, and dairy and poultry products.

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[2] Cf. Andrée Choveaux: The New Palestine, *Geogr. Rev.*, Vol. 17, 1927, pp. 75-88.

[3] Investigations are under way on the production of fodder crops and their relation to a live-stock industry—a development urged by Sir John Russell. See his "Report on Visit to Palestine, April, 1928," published by the Zionist Organization, London (1929), with the authority of the Empire Marketing Board.

The zone of plantations is restricted by soil conditions and by supplies of water for irrigation. The extent of suitable soils is pretty well known, but the area over which adequate amounts of water can be secured is probably less than that of the soils. Within the zone of plantations the outsider has proved his ability to compete with the native. Here the two are placed upon a more nearly equal basis, so far as cost of production is concerned; and, by reason of greater initiative and adoption of modern methods of tillage, the outsider is enabled to secure higher yields and a better quality of produce. Also, he is beginning to improve his methods of packing and marketing. All of these, in years of favorable yields and prices, give him a return that makes his net profit far exceed that of the native farmer.

The Soils of Palestine

The hills of Judea, Samaria, and Galilee are composed largely of hard, impervious limestones and a softer chalk, with considerable areas of basalt to the east of the main watershed of the Galilean Hills. To the west the formations dip beneath strata of marine deposits (Tertiary, mainly Upper Pliocene and Pleistocene) and alluvium, and to the east where they have been dropped down in the Jordan-Dead Sea depression they are buried beneath lacustrine and alluvial sediments of unknown thickness.

The harder limestones comprise the greater part of the Judean Hills from near Hebron northward to the vicinity of Ram Allah and underlie a part, at least, of the chalk of the Samarian Hills. The latter are composed very largely of the softer limestone, and this formation also flanks both the eastern and western slope of the Judean Hills. Lower Galilee, or that portion west of Nazareth, is made up largely of the softer chalk; and north of a line drawn from Ras en Naqura towards the northern end of Lake Tiberias the harder limestone prevails. The larger body of the basalt extends easterly from near Nazareth across the Jordan River and from the Valley of Jezreel northward to about the northern end of Lake Tiberias.

Throughout the hill regions slopes are prevailingly steep, the erosion of the surface soil is continuous, and fairly young materials are constantly exposed on the surface. Structure zones are absent in the profiles of the soils, free lime is uniformly distributed, and the subsoils are only slightly more compact than are the surface soils. Being immature, the characteristics of the soils are dominated by the parent material; within the areas of the different formations there seem to be no marked differences in the chemical composition of the soils, and there is a marked uniformity of texture and color. From north to south the color of the surface soils becomes progressively slightly lighter, although that condition is not very striking.

The harder limestone lies in nearly horizontal beds, which are in only a few places sufficiently massive to form cliffs, and the slopes of the valleys usually consist of narrow rock terraces. Throughout the central part of the Judean and Samarian Hills, from about Hebron northward to a short distance beyond Ram Allah, the top of the range is marked by rather extensive areas having smooth surfaces that are not so steep as to prevent planting and cultivation without terracing. Local watershed divides, however, are prevailingly narrow. Throughout this region the wadies lie in deep, often canyon-like, valleys whose sides can be cultivated only when well terraced. No important areas of bottom lands are developed along the watercourses, and in many places the streams occupy truly V-shaped valleys. The mantle of residual soil is, commonly, very thin, and there are but few areas where considerable amount of labor is not necessary to remove the loose stones before cultivation is possible. In many places numerous small contiguous fields are separated by stone fences built of fragments gathered from the surface, and the amount of stone remaining is a great inconvenience to the farmer. The residual soils are stiff, heavy-textured, dark reddish-brown, very calcareous clays. These soils are very tenacious when wet but crack deeply upon drying.

In the areas of the softer limestone, or chalk, the formations have weathered deeply, resulting in porous, calcareous, gray silty soils that are without evident change in texture from the underlying rock. The surface soils are friable; and the subsoils, although porous and but slightly compacted, will, in undisturbed exposures, resist erosion for long periods. The prevailing color of the surface soils is gray, and the appearance of the chalk area is lighter than the remainder of the hill region. Considerable areas of transported soils are present along the larger wadies, either as long, gentle slopes extending to the axis of the valleys from the bases of the enclosing hills, or as lower, flatter areas within the flood plains of the streams. These soils are predominantly calcareous clay loams, brown in color, and locally contain considerable amounts of fine gravel and small stones. Although derived wholly from the gray residual soils on the hill slopes, the transported materials under somewhat moister conditions have acquired darker colors through the accumulation of organic matter from a cover of grasses and weeds. The soils are still in the stage of youth, and there is no apparent leaching or segregation of lime nor the development of structural horizons. Within the chalk areas the contours of the hills are more rounded than within areas of the harder limestone, and terracing of the slopes is not so common. West of Nazareth the slopes are rolling to steep, crests of elevations are well rounded, and a very considerable part of the surface is not too steep for some type of agriculture.

Within the area of basalt the topography changes mainly to hori-

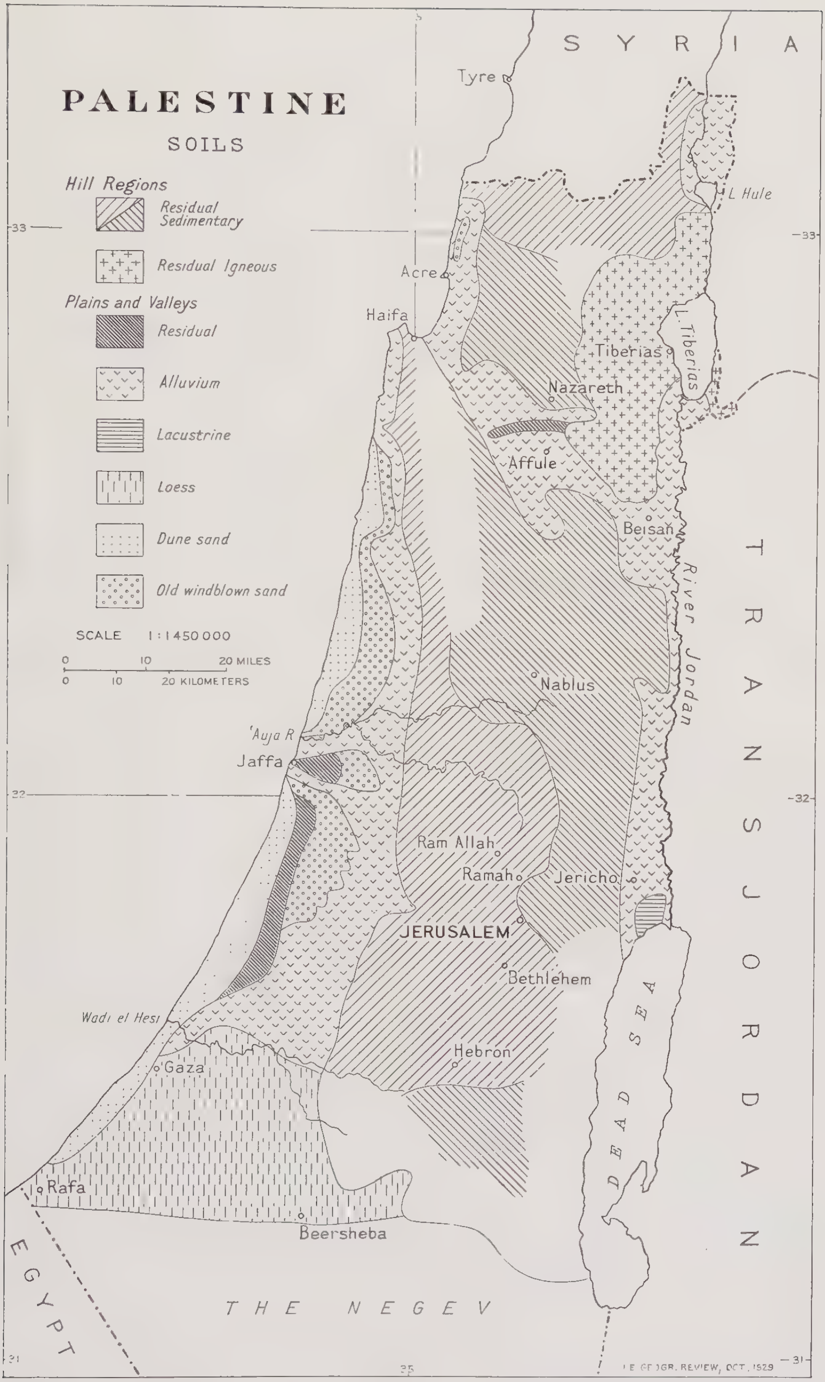

FIG. 4—Soil map of Palestine. Compare the classification on pp. 601-602. Scale approximately 1 : 1,500,000.

zontal, broadly sweeping plateaus where major differences in elevation are commonly steplike. Canyons and stream depressions are deep and narrow with steep to vertical sides. All this is in such marked contrast to the sharply uneven topography within areas occupied by sedimentary formations that it forms one of the striking features of the country.

Much of the basalt in eastern Galilee and in the Plain of Esdraelon has weathered to depths of several feet, giving rise to very dark reddish-brown to maroon clays. Along the edges of escarpments, on some of the steeper slopes, and on the crests of elevations erosion has about kept pace with the process of rock weathering, and the parent basalt is often at a depth of less than 12 inches below the surface. All of these soils shrink considerably upon drying, and cracks very commonly extend to depths of six or more feet. This characteristic is not wholly undesirable, as the soils in plowed fields usually acquire a finely divided structure without an unusual amount of cultivation. In the regions occupied by the basalt the alluvial soils are so similar to their parent residual soil that a distinction between the two is possible only where topographic forms clearly indicate the mode of development.

Soils of the Maritime Plain

In the Maritime Plain the soils present such a complexity as to origin, formation, structure, and drainage that only a few of the outstanding features can be given much consideration.

The oldest soils on the plain have been derived from the weathering of a series of old marine clays (Eocene) that have been tilted and uplifted to form the elevated portion of the plain east of Gaza. The parent material is a succession of gray, brown, and reddish-brown stratified clays. These are highly calcareous, and nodules of lime and incrustations in seams and cavities are of not uncommon occurrence. The soil that results from the weathering of these clays is a grayish-brown clay loam or clay. The structure is compact, free lime is always present, and nodules and concretions are usually abundant. Where the surface has been broken erosion is active, and a typical badland topography has been developed over a large area southeast of Gaza. The areas of this soil, together with that of the loess, lie between Beersheba and Wadi el Hesi and form the most elevated section of the Maritime Plain. The general surface elevation is not far from 500 feet above sea level, and a number of prominent ridges north of Beersheba attain elevations of nearly 1000 feet.

A thin mantle of loess, overlying the old stratified clays, extends from about Wadi el Hesi southward for an undetermined distance into the Negev. The thickest exposure noted was in a wadi bank, some 15 miles southeast of Gaza, where about 20 feet of fine, buff-colored

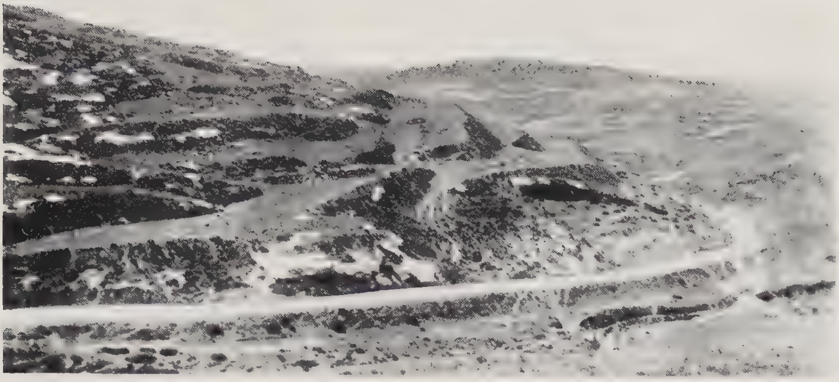

FIG. 5

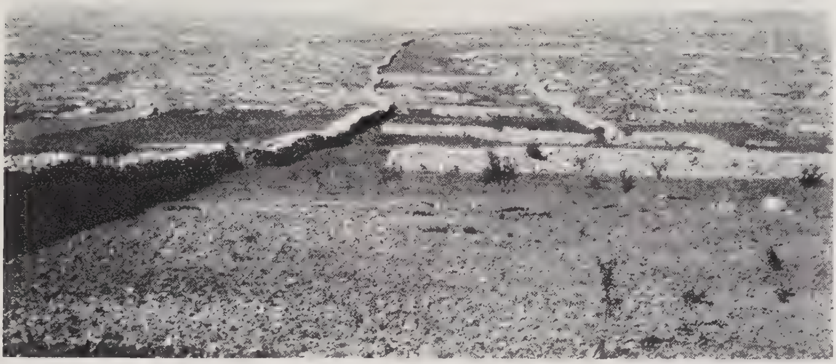

FIG. 6

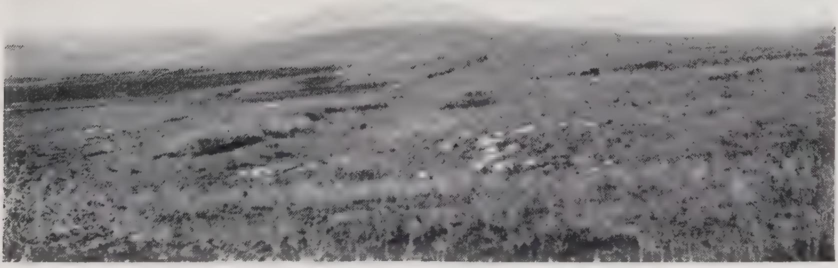

FIG. 7

FIG. 5—In the Samarian Hills the porous soils are little subject to erosion. The fronts of the terraces are protected only by growths of weeds and grasses.

FIG. 6—Stone walls for fences on the stony fields of the Judean Hills.

FIG. 7—Basalt soils in southern Galilee, east of Nazareth. The flat topography contrasts sharply with the steep hills and deep narrow valleys of the limestone areas.

wind-laid soil had accumulated. Much of the loess is very thin, and the underlying clays are often exposed in cuts along the Gaza-Beersheba highway and upon the narrow crests of ridges and elevations. Both the surface soil and the subsoil of the loess are a very fine sandy loam that is unchanged in either color or texture to a depth of more than six feet. The surface soils are porous and friable. The subsoils are so slightly compact that fragments offer but little resistance to crushing in the hand, and exposures show a faintly columnar structure. A shrinking and cracking—characteristic of the greater part of the soils of the plain—is not characteristic of this soil. This loess possesses that peculiar quality, which characterizes loess the world over, of maintaining vertical walls in exposures for long periods. The entire profile of the soil is slightly calcareous, and chemical analysis fails to show any noticeable concentration of lime at any depth below the surface.

A series of highly calcareous, stratified, coarse-textured sandstones extend as a narrow ridge along the coast from Gaza northward to the Syrian boundary. These sandstones, which were apparently continuous at one time, have been cut through by some of the larger streams passing to the sea, and large areas are now obscured by an overburden of wind-blown sand. The sandstones are very little resistant to weathering agencies, and their visible extent is marked by a succession of low, rounded hills and ridges having a topography not greatly unlike the bordering areas of wind-blown sand. The soil resulting from the weathering of the sandstone is coarse-textured, porous and leachy, and of a light gray color upon elevations and steep slopes but of a dark gray to brown upon lower slopes and in depressions where better moisture conditions have favored an accumulation of organic matter. Upon crests of elevations the parent rock lies close to the surface, and fragments of the soft sandstone occur throughout the soil. At lower elevations the sandstone is usually more than six feet below the surface, largely because of the transportation of the residual soils down the slopes. All of the soil is highly calcareous, with the lime apparently having a very uniform distribution.

Wind-blown Soils of the Maritime Plain

The wind-blown soils constitute the most important area of soil on the Maritime Plain from an economic standpoint, and they present some features with respect to chemical and physical composition that are unusual and not yet fully understood. These sands consist both of materials that are still in the process of accumulation and of materials that have been long in place.

The recent sands are almost continuous along the length of the Mediterranean coast, where they form extensive areas of mobile dunes. Picturesque as dunes may be, they are undesirable neighbors in an agricultural region. Moving slowly and irresistibly inland they are burying productive citrus groves and vineyards in many places and, in others, lands well adapted to the production of dry-farmed cereals and to grazing. Futile attempts toward arresting the movement of the sand have been made in a number of places by planting trees along the lee side of the dunes. This simply retards the movement for a short period and is far from being an effective method of control. Although some work has been done by the government to control the march of the dunes, the task seems almost insurmountable; and a very considerable area of agricultural land is certain to be destroyed in the near future.

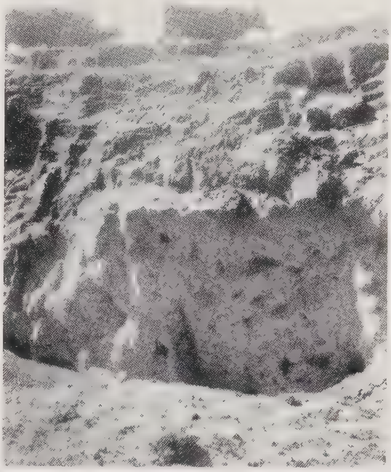

FIG. 8—Typical profile of old reddish wind-blown sands (Deiran series) on the Maritime Plain. The substratum is a yellowish, nearly structureless fine sand that is mildly calcareous. The surface soil and subsoil are noncalcareous or slightly acid and are the only soil materials in Palestine possessing that characteristic.

The older wind-blown materials, immediately to the east of the recent dunes, are not only a striking feature of the physiography of the plain but possess marked differences in crop adaptation and are, when measured by potential crop returns, the most valuable soils in Palestine. They represent accumulations of wind-blown sand which have been stationary for so long that weathering has developed pronounced changes in color, texture, structure, and chemical composition. The surface soils are, prevailingly, light reddish-brown loamy sand, although they are locally loams and are locally brown where conditions have allowed accumulations of organic matter from a grass cover. This brown surface is from two to four inches thick and disappears when deep plowing mixes the surface soil with the underlying material. The subsoils are dark reddish-brown to maroon in color, are slightly heavier in texture than the surface soil, and possess a slight compactness which is sufficient to hold the sides of old war trenches in the position in which they were dug. The color, texture, and structure of the subsoil extend without evident change to an average depth of about eight feet, when it is abruptly underlain by a substratum of fine yellow sand that is without evident structure. Soil and subsoil are noncalcareous, and the substratum is only slightly calcareous. The condition is of unusual interest as this is the only soil formation in Palestine that is lacking in an abundance of free lime.

The above-mentioned conditions of color, texture, and structure characterize the greater part of the soils within the area of this formation, but there are a number of more or less local conditions which govern the value of the soils for agriculture. Most widely developed in the Plain of Sharon is the compacted stratum termed "nasaz" by the native farmers, which practically obstructs subsoil drainage and effectively limits the penetration of the roots of cultivated crops. This stratum is dull grayish-brown to light reddish-brown in color and is brilliantly mottled with splotches of red, yellow, and black. The texture of this material is seldom heavier than a sticky loam, and sandy loam and fine sandy loam textures seem quite prevalent. The structure is peculiarly compact and, although not wholly impermeable, greatly restricts the movement of moisture; and the overlying soil remains wet for long periods after rains or irrigation. Nasaz occurs at an average depth of about 30 inches below the surface, although in very restricted bodies it will be found practically at the surface. Its thickness is a foot or more, and occasionally it will extend to depths of more than six feet.

Not enough is yet known as to the relation of nasaz to topography to afford a basis for predicting its presence. It seems probable that its most usual occurrence is along small wadies or on adjacent slopes, although it is occasionally found upon the tops of knolls 25 feet or more above the streamways. Its extent cannot be given at the present time. Certainly it is most abundant in the district north of the 'Auja River, but it has been encountered as far north as Benjamina colony and for a distance of at least ten miles south of Jaffa. The condition of impeded drainage and restricted zone for root development absolutely precludes the satisfactory development of orchards and vineyards; and, as such crops are ordinarily very profitable, a careful survey of the soils of this group solely for the purpose of determining the extent of the nasaz would seem a worth-while undertaking.

An equally important condition, but one which is localized and apparently of limited extent, is the presence of a dull-gray clay, of very compact structure which contains small, hard, rounded calcareous concretions uniformly distributed to a depth of more than six feet. So far as is known, this condition occurs only in a few places in the vicinity of Raanana, west of the Arab village of Kfar Saba. Such bodies of soil have no value, other than for a scanty grass cover that affords some grazing. The origin of this condition is not known. However, it bears some resemblance to the compact marine sediments east of Gaza; and, although that material has not been identified in the central portion of the Maritime Plain, these bodies of clay open up a field for conjecture as to the area once occupied by the marine deposits.

The remainder of the soils on the Maritime Plain consist of waterlaid materials brought down from the hill regions. They are neither mature nor recent. In no case have they reached a stage of development where the surface soils have lost an appreciable amount of lime, nor are there any evident segregations of lime at any depth. With the exception of narrow areas along the base of the hills, where there are annual accretions of eroded material, all the soils have been in place long enough to have lost the colors of their parent residual soil and, where well drained, show something of the influence of the variation in rainfall in the different portions of the plain. In the vicinity of Wadi el Hesi, where the annual rainfall is about 15 inches, the surface soils are light brown in color and the subsoils only slightly darker. The rainfall increases rather uniformly northward, and with this increase the soils become brown, then dark brown, and finally almost black in the vicinity of Haifa and Acre.

Tentative separation of the older from the more recently deposited waterlaid soil can be made only on the basis of differences in topography, as there is no marked difference in either chemical or physical properties. In many places typical flood-plain forms are strongly indicated.

The surface soils of the recently deposited material consist of loams, silt loams, clay loams, and clays; and the subsoils are predominantly clays with recognized areas in the southern part of the plain where subsoil textures are not heavier than silt loams. Gravel is ordinarily present only along the base of the hills, but in the northern part of the plain a few of the larger wadies have carried a burden of small stones and gravel well out toward the coast.

Drainage conditions are generally good, excepting for comparatively limited areas of swamp and marshland near the coast, due either to the inability of the stream to maintain its channel to the sea through the shifting dunes or to the low elevation of the flood plain of the stream. Traces of soluble salts are usually present in the soils in such locations: excessive amounts occur only in the marsh along the lower reaches of Nahr ez Zarqa and in a few isolated areas northward along the coast for a distance of some six or seven miles.

Esdraelon, Jezreel, and Beisan

The residual soils within the Plain of Esdraelon are largely coincident with a broad, low ridge extending from the western end of Jebel Duhi across the valley to near the Hill of Megiddo. The parent material is a fine-grained basalt which, in weathering, gives rise to a very dark reddish-brown calcareous clay. This soil is seldom as much as six feet in depth and over considerable areas does not exceed two feet. Soils derived from the weathering of sedimentary formations are of limited occurrence and of little importance.

The parent material of the alluvial soils of the plain consists of the products derived from the weathering of both sedimentary formations and from basalt. Only in local areas, as on a number of alluvial fans, has the soil been derived wholly from one or the other of those formations; the greater part of the soils of the plain consist of undifferentiated materials from both sources. The soils on the Plain of Esdraelon have developed under a more abundant rainfall than have most of the other alluvial soils of Palestine and are prevailingly darker-colored, heavier-textured, more sticky and tenacious when wet and apparently have a greater moisture-holding capacity. During the latter part of the summer of 1927 it was noted repeatedly that these soils were definitely moist below a depth of about 20 inches, while the soils on the Maritime Plain contained barely perceptible amounts of moisture. Although the greater part of the soils of Palestine shrink and crack on becoming dry, that condition is most strongly developed in the Esdraelon. The cracks are of unusual width, a depth of at least six feet is common, and cracks nine feet deep were observed in a number of places. Only when these soils are deeply and thoroughly tilled is the separation of the subsoil reduced or wholly overcome.

The alluvial soils of the plain are brown, dark-brown, or black calcareous clays, and the subsoils are prevailingly dark-brown and dark reddish-brown compact clays. These are calcareous, but there has been no evident segregation of lime at any place in the profile. Differences in the colors of the surface soils are closely associated with differences in local drainage. West of Affule and southwest of Nahalal considerable areas have flat and uniformly surfaced slopes, and the soils in those districts remain excessively wet for several months of the year. In such areas the surface soils are black. Where there is better drainage, the surface soils are brown to reddish brown.

The Plain of Esdraelon and the Valley of Jezreel form a continuous depression extending transversely across Palestine. The soils throughout the length of these districts differ in no respect in the character of their parent materials or in mode of formation, but where drainage is normal there is an observable relationship between the colors of the surface soils and the rainfall. With an average annual precipitation of 20 inches or more a dark reddish-brown color predominates; with a decrease in precipitation lighter colors become apparent, and under a rainfall of about five inches, near Beisan, pale reddish-brown to grayish-brown soils are the rule. Exceptions occur in areas of less efficient drainage, as in the flood plain of the Jalud River or on alluvial fans where recently deposited materials have not yet been affected by local climatic conditions. In the Valley of Jezreel the alluvial soils are predominantly clay loams, reddish brown in color and highly calcareous. Small amounts of soluble salts are present in the soils in the eastern part of the valley.

The Plain of Beisan is a roughly rectangular-shaped area situated in an embayment between the base of the Samarian Hills and the Jordan, south of the Jalud River. The soils are probably wholly alluvial, in that they are composed of débris brought down by streams draining the eastern slope of the Samarian Hills, although it is possible that there are areas having soils derived in part from the weathering of old lake-laid materials. The surface soils are predominantly dull grayish-brown silt loams which are highly calcareous and often contain small amounts of alkali. The subsoils are similar or somewhat lighter in color and are either clay loam or clayey in texture. The plain is dotted with small springs, and near them the surface soils are black, high in organic matter, and excessively wet for much of the year. The alkali is not present in sufficient amounts to be dangerous, unless overirrigation results in water-logging.

Soils of the Ghor

In the great Jordan-Dead Sea depression, which extends for nearly the full length of the eastern boundary of Palestine, the soils exist under both truly arid and nearly humid conditions. Large areas are swampy, some parts are subject to intermittent overflow, and in other parts drainage is good or excessive. Near the Dead Sea the rainfall is about five inches during the winter months, and extreme dryness and heat are the rule during the rest of the year. Near the Syrian boundary the annual rainfall is about 30 inches, winter is moderately cool, and summer heat is extreme only for short periods.

At the northern end of the depression is the Hule region, a partially enclosed basin containing an extensive alluvial plain, the large Hule Marsh, and Lake Hule. The alluvial soils on the plain are largely reddish-brown clay loams derived from both igneous and sedimentary formations. They are calcareous but without structural horizons or concentrations of lime. The soils within Hule Marsh are not accessible, but around the margin they are black, slightly calcareous, heavy-textured silt loams containing large amounts of organic matter. The soil is submerged throughout the year and covered with a dense growth of papyrus and other water-loving plants. The alluvial plain is slowly encroaching upon the marsh through the deposition of stream sediments, and the marsh is slowly reducing the area of the lake as vegetation keeps pace with the shoaling of the water.

A high rocky plateau intervenes between the Hule region and Lake Tiberias. Here outcropping masses of both limestone and basalt form a rolling to broken surface; and the soils, wholly residual and commonly thin, are of little agricultural worth.

With the exception of the Plains of Gennesaret and Semak, Lake Tiberias is closely hemmed in by the cliffs of the basalt plateau of eastern Galilee and by those forming the eastern boundary of the plateau that comes down from Transjordania. Recent alluvial sediments form the plain of Gennesaret. These are friable, dark-brown, gravelly, heavy-textured loams underlain by subsoils that are clay loams containing varying amounts of waterworn gravel. The soil on the Plain of Semak is the most northerly known representative of a series of lake-laid sediments that extend southward beyond the Dead Sea. The elevation of this body of soil at Semak is about 15 feet above the usual level of Lake Tiberias, and this would indicate the probable presence of similar soils around the shore of the lake. No areas have, however, been so far identified. The surface soil is a porous, friable, grayish-brown silt loam. The subsoil, to an average depth of more than six feet, is similar in texture and color, but the structure is somewhat more compact than that of the surface. The substratum is a series of thinly stratified, partially consolidated sediments that range in texture from fine sand to clay. Small amounts of soluble salts are rather uniformly distributed throughout both surface soil and subsoil, but the amounts are not dangerous unless drainage becomes obstructed.

South of the lower end of the Plain of Semak the hills close in on both sides, and the Ghor is narrowed to a strip of uneven and eroded land extending southward nearly to the mouth of Wadi Abu Sidra. From this wadi southward the Ghor gains increasing width and reaches a maximum of about 12 miles near the northern end of the Dead Sea. Throughout this extent the soils fall into two main groups: those derived from the weathering of old lacustrine sediments and those on the more recent alluvial fans. The latter constitute the long uniform slopes that sweep from the base of the hills toward the axis of the valley. The surface soils are clay loams and loams, light reddish-brown in color, strongly calcareous, and often contain considerable amounts of stream gravel and small stones. The thickness of this alluvium decreases rapidly with distance from the hills, and the subsoil is largely made up of lake-laid silts and clays. The surface soils do not often contain sufficient amounts of soluble salts to affect cultivated crops, but the subsoils are usually heavily charged with alkali—largely sodium chloride. The areas of these soils in which there is not too much alkali to prevent cultivation is confined to a relatively narrow strip along the lower slopes of the hills. The rest of the soil is worthless for all forms of agriculture.

The old lacustrine sediments occupy a large area north and west of the Dead Sea. These are grayish, heavy-textured materials, largely clays, containing alkali salts and gypsum in such quantity that crystals are commonly visible in the stratifications. The soil, resulting from the weathering of these sediments, is a gray to dark-gray clay with local inclusions of soils of lighter texture. The subsoil is of similar

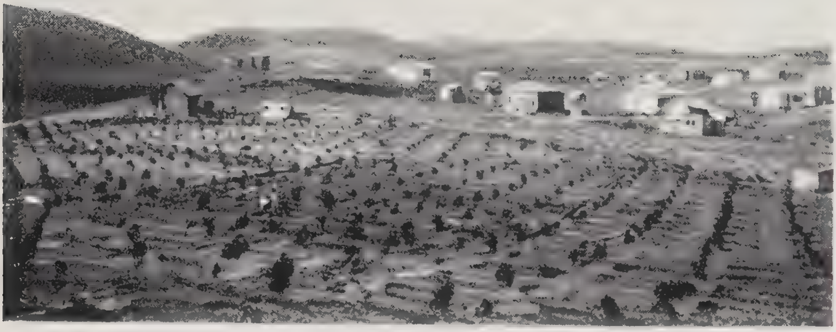

FIG. 9

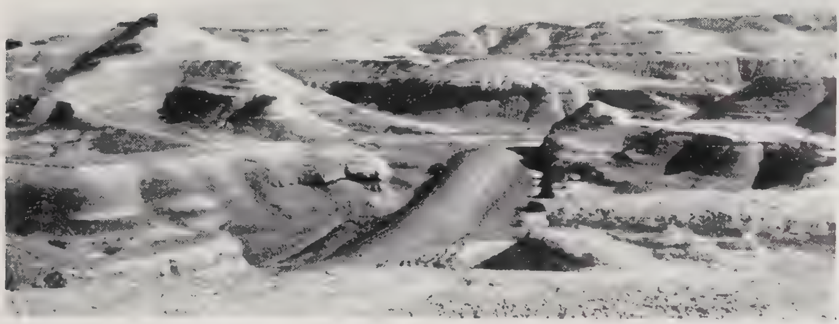

FIG. 10

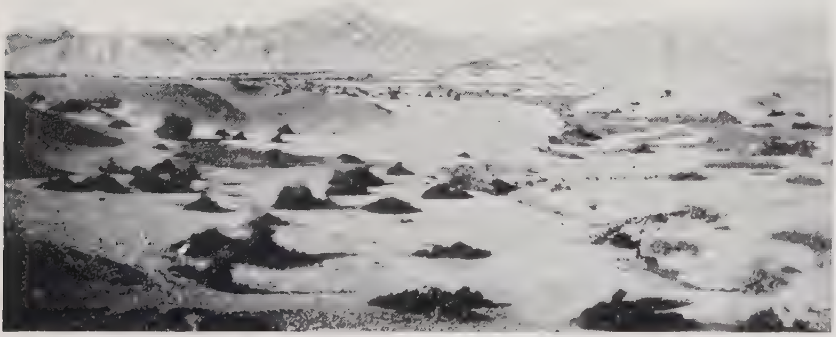

FIG. 11

FIG. 9—In the background rolling hills of residual soils (Belain series), derived from a coarse-textured, calcareous sandstone. In the foreground old reddish wind-blown sands (Deiran series) with a new planting of citrous trees.

FIG. 10—The lacustrine sediments (Dead Sea series) in the lower Jordan Valley erode easily, and considerable areas have a badland topography.

FIG. 11—The Ghor west of Jericho. Wadi Kelt, in the center, drains a large area in the Judean Hills but is dry for almost the entire year.

texture but is mottled with reddish and yellowish streaks. The surface soil has a thin, moderately firm surface crust and is underlain by a granular subsurface mulch caused by the large amount of alkali salts that are present. The subsoil and substratum are compact. Large areas of this soil are barren, and none of it has any agricultural value whatever. The soil erodes rather easily and tends to development of a badland topography.

Although of no economic importance, it would be interesting to know at what point, during the decrease in the size of the sea, the dissolved salt content of the water became markedly saline. Analysis of the sediments in the Plain of Semak shows a soluble salt content ranging from about .3 to about .5 of 1 per cent. At Wadi Abu Sidra, where the valley again opens out, the soluble salt content of the sediments is rarely less than 1 per cent and occasionally as high as 3 per cent. At some point between the lower end of the Plain of Semak and the wadi it should be possible to determine the horizon at which the lake water began to accumulate rather large amounts of dissolved salts.

THE NEGEV

The Negev literally means the "Southland" and is used here to include that part of Palestine south of a line east and west through Beersheba. This division is purely arbitrary. There is little information concerning this region, a desolate, arid land without permanent habitation. Occupied by the nomad Bedouin and his herds of camels during the rainy season, it is practically abandoned during the summer and fall when the herds move north in search of new pasture. The topography is a more or less disconnected system of hills, mountains, sandy plateaus, and intervening wadi depressions. There are no permanent streams; but the wadies, dry for almost the entire year, are occasionally torrential in their discharge after unusually heavy, and rather rare, rains. Practically nothing is known of the soils in the Negev other than that they are prevailingly sandy in texture, that there are areas of loess of undetermined extent south of Gaza, and that considerable areas are occupied by moving dunes.

CLASSIFICATION OF SOILS

Reconnaissance of the soils resulted in the establishment of several broad groups according to origin and formation. It is recognized that each of these groups contains soils that vary widely, not only in physical features but also in chemical composition and in value for crop production. Determination of the location, extent, characteristics, and utilization of these varieties can be made only by systematic and intensive study. The broad classification, resulting from several months of field work, is as follows:

1. Residual soils
    - A.* Hard limestones, principally in the Judean and Samarian Hills
        - a. Reddish clay soils; very stony; rolling hills and ridges; calcareous; soils often shallow: Judean series
    - B.* Soft limestone, or chalk, principally in the Samarian Hills
        - a. Gray silty soils; porous; calcareous; stones usually not abundant; rolling hills and ridges: Samarian series
    - C. Basalt in Galilean Hills and Plain of Esdraelon
        - a. Very dark reddish-brown clays; compact; calcareous; moderately rolling: Adamah series, 7600 acres**
    - D. Soft, coarse-textured, calcareous sandstone in Maritime Plain
        - a. Grayish to light-brown coarse sandy loam; soil often shallow and leachy; very calcareous; rolling hills: Belain series, 24,100 acres
2. Alluvial soils
    - 2a. Moderately old alluvium
        - A. Undifferentiated sedimentary formations
            - a. Light to dark reddish-brown clay loam and clay; poor surface crust and mulch development; no development of subsurface or subsoil layers; uniformly calcareous; locally stony and gravelly; drainage good; moderately rolling ridges; Maritime Plain: Shahmeh series, 185,800 acres
            - b. Light-brown to light reddish-brown loams and clay loams; uniformly calcareous; locally gravelly; subsoil drainage often restricted; locally excessively alkaline; gently sloping ridges and alluvial fans; Jordan Valley: Jericho series, 38,000 acres; Jordan series, 6700 acres
        - B. Basalt
            - a. Dark-brown to maroon clays; deep and well drained; calcareous; no development of soil layers; soils crack deeply on drying; Plain of Esdraelon and Valley of Jezreel: Tabaun series, 12,200 acres
        - C. Mixed origin—sedimentary and igneous formations
            - a. Dark-brown to black clays; calcareous; locally poorly drained; free from alkali; soils crack deeply on drying; smooth to gently rolling; Plain of Esdraelon and Valley of Jezreel: Affule series, 54,400 acres; Tel Thorah series, 16,600 acres; Beth Alpha series, 1800 acres
            - b. Gray to dark grayish-brown loams to clay loams; very deep or underlain by partly consolidated strata of lacustrine sediments; locally slightly alkaline; drainage fair to good; Plain of Beisan: Beisan series, 5900 acres
    - 2b. Moderately recent alluvium
        - A. Undifferentiated sedimentary formations from hill regions
            - a. Brown to dark-brown clay loams and clays; calcareous; surface flat; drainage good to deficient; alkali in restricted districts; Maritime Plain: Sakia series, 86,400 acres
        - B. Mixed origin—limestone, lacustrine sediments, and loess
            - a. Very light-brown to brown fine sandy loams to clays; calcareous; surface smooth; drainage good; no alkali; Maritime Plain: Saphir series, 47,400 acres; Imleih series, 41,600 acres

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*Areas of *A* and *B* were not determined, as the field work did not go into any detail within the region of sedimentary formations.

**Includes only area covered by reconnaissance. Other areas occur in northern Palestine.

- C. Mixed origin—sedimentary and igneous formations
  - a. Dark-brown to black loams and clays; calcareous; drainage good; no alkali; surface smooth; Jordan Valley: Gennesaret series, 2800 acres

3. Lacustrine soils
   - A. Mixed origin
     - a. Gray to light reddish-brown loams to clay loams; calcareous; drainage good to deficient; large areas highly alkaline, others free; Maritime Plain and Jordan Valley: Dead Sea series, 45,900 acres; Ruhama series, 37,700 acres; Semak series, 16,300 acres
     - b. Black silt loams very high in organic matter; slightly calcareous; drainage very deficient; Hule swamp: area not known
4. Wind-blown soils
   - 4a. Recent deposits
     - A. Mixed origin
       - a. Yellow sand dunes along Mediterranean coast, 67,300 acres
   - 4b. Old deposits
     - A. Mixed origin
       - a. Grayish-brown to reddish-brown sands to loamy sands; noncalcareous or but faintly calcareous; friable; drainage good to excessive; hummocky to hilly topography; Maritime Plain: Deiran series, 104,200 acres; Tumrah series, 15,300 acres
5. Windlaid soils—loess
   - A. Mixed origin
     - a. Very light-brown, or tan, very fine sandy loams to loams; slightly calcareous; subsoil very slightly compact; drainage good; no alkali; moderately rolling; Maritime Plain: Beersheba series, 158,800 acres
6. Undifferentiated series
   - A. Alluvial and wind-blown soils
     - a. Grayish-brown to dark-brown sand and clay; calcareous; friable to compact; drainage good; undulating; Maritime Plain: Shahmeh and Deiran series, 4500 acres
   - B. Alluvial and residual soils
     - a. Reddish-brown to maroon clays; calcareous; compact; drainage good; undulating to hilly; Jordan Valley: Tabaun and Judean series, 15,700 acres

The soil map (Fig. 4) shows the distribution of the major groups of the soils of Palestine according to their formation. The boundaries between the residual soils from sedimentary formations in the hill regions have not been determined; and, owing to the meager information concerning the Negev, no data are given for that region.

GEOGRAPHY OF A SUGAR DISTRICT: MARIEL, CUBA*

Robert S. Platt
University of Chicago

THE study here presented exemplifies a type of regional geographic work. It deals with what may be termed the pattern of human occupancy in a small district in a tropical agricultural region.[1] Mariel is one of the smaller ports of Cuba, shipping about one per cent of Cuban exports. In the district back of the port is the Central San Ramón, one of a hundred and eighty sugar mills in Cuba.

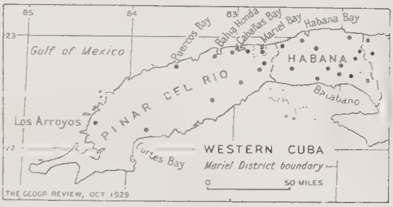

FIG. 1--Location of the Mariel district.

LANDSCAPE AND CANE DISTRIBUTION

West of Havana the first break in the rocky coast is at the Bay of Mariel. Around the bay is rolling lowland, farm country. East and south of the bay the lowland is bordered by an escarpment two hundred feet high, beyond which there is a plain at the higher level, somewhat broken to the east but smooth to the south. The district has an area of sixty-five square miles, of which about thirty-eight per cent is occupied by sugar cane.

There is no cane in a strip along the rocky exposed coast nor in the swampy land at the head of the bay nor on very steep slopes. Aside from these unfavorable areas most of the land is cultivable, and most of it has been cultivated at one time or another. Yet only about half of it is under crops at present. Most of the soil is brown silt loam, overlying limestone, but there are considerable differences in productivity, due to differences in slope and soil. Even where there are not obvious differences in soil type planters have classified their land from past experience, finding that some fields produce more than thirty tons of cane per acre and others less than fifteen tons the first year

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* For invaluable assistance in making this field study special acknowledgment is due to Dr. Francisco José Velez of Mariel and Señor Norberto Sorhegui of Rio Hondo.

[1] Studies of a similar type by the author are: "A Detail of Regional Geography: Ellison Bay Community as an Industrial Organism," *Annals Assn. of Amer. Geogrs.*, Vol. 18, 1928, pp. 81–126; "Field Study of Republic, Michigan: A Community in the Marquette Iron Range," *Scottish Geogr. Mag.*, Vol. 44, 1928, pp. 193–204; "Pattern of Land Occupancy in the Mexican Plateau from Field Study of a Pueblo," to be published in a forthcoming bulletin of the Geographic Society of Chicago.

after planting. In each succeeding year the yield is about thirty per cent less than the year before until, after four, five, or six years, according to the soil, it is less than five tons per acre. Neglect of soil and delay in replanting, due partly to years of depression and restriction in the sugar industry, have reduced the average yield to less than twelve tons per acre.

Much poor land is left uncultivated, as being unprofitable in the present state of the industry. In addition, some good land is left uncultivated, to rest for at least one year after a series of cane-producing years and incidentally to provide pasturage for work animals. The proportion of land left uncultivated tends to be greater in less accessible areas than in those more favorably located.

Other Features of the Pattern of Distribution

Thus it appears that the distribution of cane production has obvious relations to land surface features. This geographic fact is a preliminary to the more complex geographic fact that the distribution of land control, production, transportation, population, and the whole human organization of the district forms an intricate pattern of human occupancy of the land.

This pattern is not determined by the natural environment. Many features are related only indirectly or historically to natural conditions, and some better adjustments might be made. Yet the pattern belongs definitely in its natural setting, meeting all the requirements of nature and accepting certain of the opportunities.

Property Division

In the development of the pattern land tenure is fundamental. The property division of today is unsatisfactory in many respects and might be called unnatural and poorly adjusted. Yet various weaknesses in the present were natural arrangements in the past, and their acceptance and gradual modification now are more reasonable than their complete elimination.

Property division began in the sixteenth century, when grants were made by the king of Spain. *Corrales* for stock raising were of circular form, one league in radius from a given center.[2] This system seemed natural and suitable at first. The country was empty and unknown; settlers were few and far between. The selection of a center was important, and the determination of boundaries unimportant. But when the country became populous the boundaries as well as the centers became important. The grants were faulty in location, difficult

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[2] F. J. Velez: Geografía médico-sanitaria del Término Municipal del Mariel, Habana, 1927. On the general question of property division see also Ramon de la Sagra: Historia física, política y natural de la Isla de Cuba, Paris, 1842, Vol. 1, p. 230.

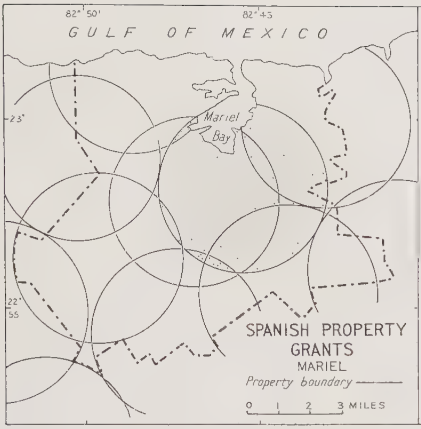

FIG. 2

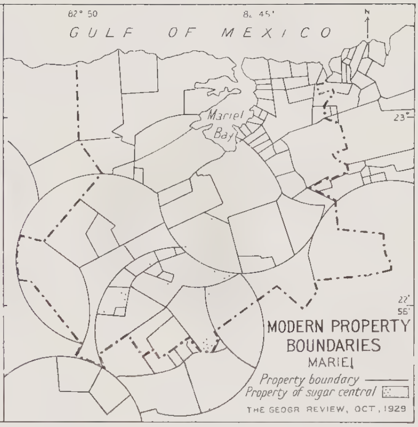
82° 50
82° 45'
N
GULF OF MEXICO
23°
Mariel Bay
22° 55'
MODERN PROPERTY BOUNDARIES
MARIEL
Property boundary
Property of sugar central
THE GEOGR REVIEW, OCT, 1929

FIG. 3

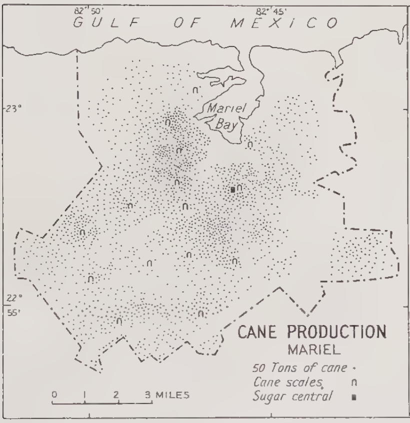

FIG. 4

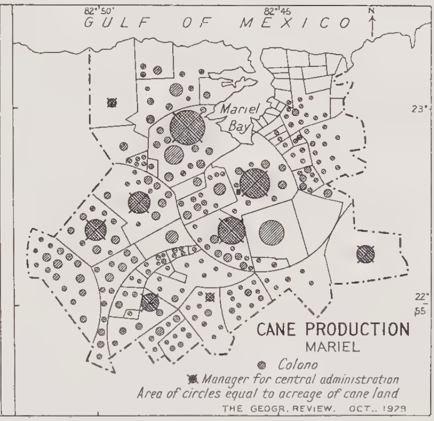
82° 50'
82° 45
N
GULF OF MEXICO
23°
Mariel Bay
22° 55
CANE PRODUCTION
MARIEL
Colono
Manager for central administration
Area of circles equal to acreage of cane land
THE GEOGR. REVIEW. OCT., 1929

FIG. 5

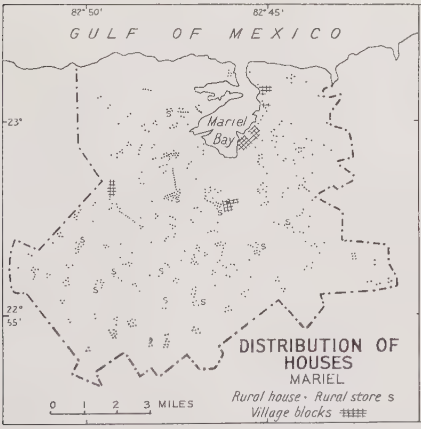

FIG. 6

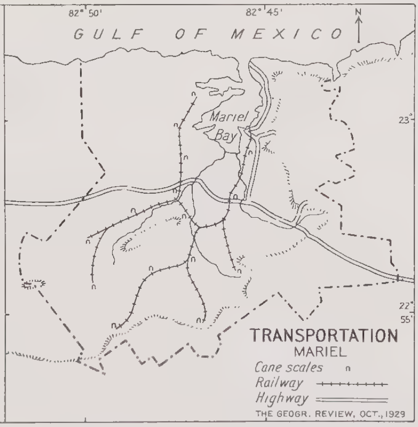

FIG. 7

FIGS. 2 to 7—Sketch maps illustrating the distribution of property, cane production, population, and transportation in the Mariel district, western Cuba. In Figure 2 the first royal grant in the district is stippled.

to survey, impossible to harmonize, and too large to be occupied as units, each having an area of eighteen square miles. Confusion resulted. Gradually property was divided up, and boundaries were fixed by compromise agreements.

When the sugar industry developed, the circles were divided into new units—plantations based on the old property divisions but dimensioned to fit the new use of the area, located to contain several hundred acres of cane land, each plantation worked by slave gangs and served by its own sugar mill.

Now slave gangs have been superseded by free laborers, and small mills have been superseded by large centrals. These two changes have involved a readjustment of landholding in two opposite ways. A larger area of land is required by the central than by the small mills. At the same time the employment of free labor permits the effective working of smaller areas of land.

Accordingly there has been a concentration of landownership in a few hands. For instance, the owners of the Central San Ramón (a Cuban family controls and manages the company) hold forty per cent of the cane land of the district and have indirect control over the rest of the cane land. The Central San Ramón takes the cane from 16,000 acres, which formerly went to at least seventeen plantation mills.

Simultaneously for farm operations the old plantations have been subdivided into small tracts and rented to tenant farmers. In the Mariel district two hundred and twenty-five *colonos* produce cane, a majority of them on less than 20 acres, a few of them on more than 200 acres. Independent production is fostered by the central. The company maintains production on part of its own land and occasionally takes over other land from expediency rather than from choice.

Maps of one plantation, called the "Finca Mariel," serve to illustrate details of land division. The plantation is near the central and extends from swamp land near the bay to an outlier of the escarpment. It has an area of 970 acres, formerly operated as a unit with its own mill. Now it is owned as a unit but divided among twelve producers, one of whom is a manager appointed by the central.

The *colonias* of the Finca Mariel are from 10 to 450 acres in area, irregular in form, marked off by convenient but inconspicuous landmarks. Fifty-three per cent of the land is occupied by cane, five-sixths of it ready to harvest (1928), in irregular fields fitting into the landscape. Workers' houses are distributed conveniently in the *colonias*, with fruit and vegetable patches near by.

Distribution of Workers

Throughout the district rural population is distributed near cane fields. Each laborer lives and works in a small area, averaging eight acres of cane per man—small enough for considerable grouping of houses without taking workers far from their fields.

The houses are simple structures, palm-thatched, well suited to the climate. They seem adapted even to the hurricanes which occur every three or four years on the average; because the relatively weak supports tend to give way and let the heavy roof sink to the ground and form a shelter for the occupants during the storm.

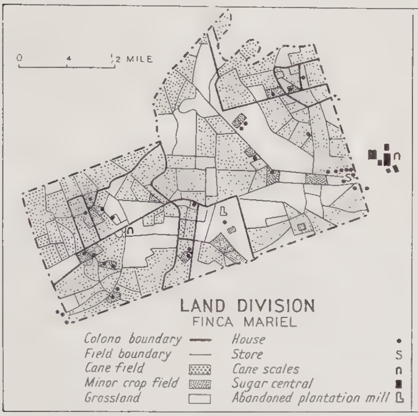

FIG. 8

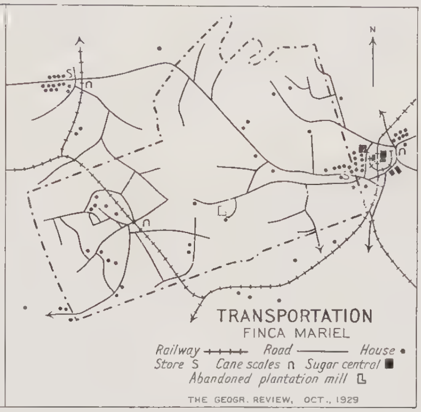

FIG. 9

FIGS. 8 and 9—Sketch maps illustrating agricultural economy and transportation in the Finca Mariel, one of the plantations of the Mariel district.

The house groups are on knolls, at crossroads, or at centers of old plantations, with some advantages natural or accrued, such as water supply and stores.

Among the people are white settlers or their descendants as well as black descendants of slaves. Almost a thousand families are on the land, in accordance with the intensive requirements of cane production. Of the labor in the industry at least ninety per cent is in the fields and ten per cent in the central, in contrast with the fact that of the capital invested in the industry hardly ten per cent is in the fields and about ninety per cent is in the central. The central itself is well designed to perform its function and is suitably located in the midst of its district.

SYSTEM OF TRANSPORTATION

The change from small mills to large central, drawing many little districts in to one large district, brought the inevitable need of a new system of transportation, to carry the cane crop of 160,000 tons to the central, a much greater distance, but just as quickly as to the old plantation mills.

The system of transportation is a vital feature of the pattern of

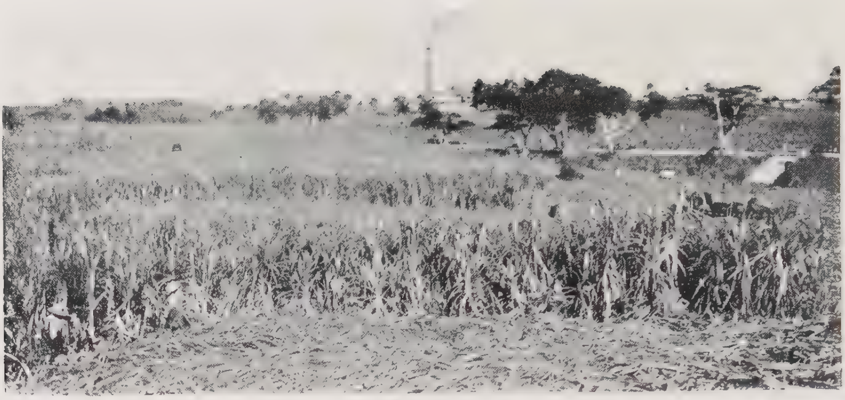

FIG. 10

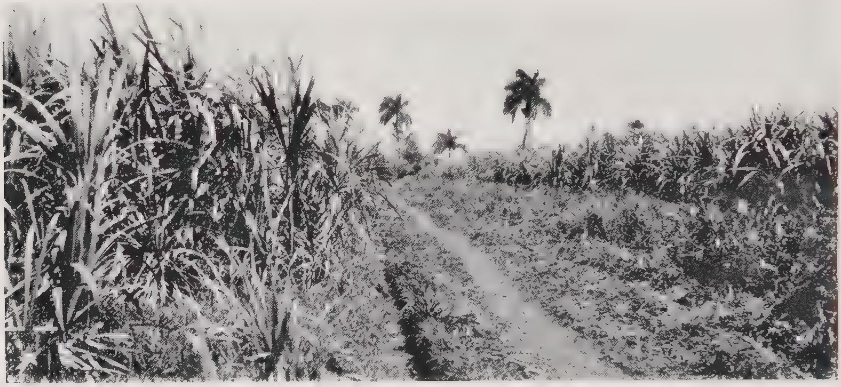

FIG. 11

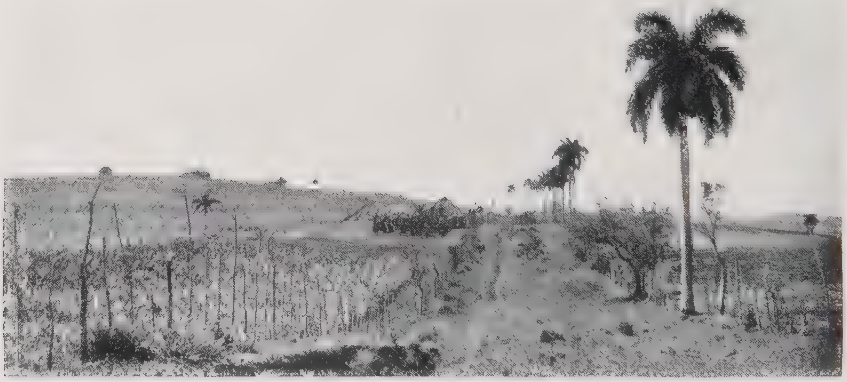

FIG. 12

FIG. 10—Central San Ramón and near-by cane fields. Highway at right. Harvest time; men cutting along edge of standing cane, cart loading cane at right, oxen grazing on stripped leaves.

FIG. 11—Passageway for carts between cane fields. Such lanes serve for fire protection as well as for transportation.

FIG. 12—Boundary of the Mariel district. An old plantation boundary marked by royal palms; cart road along boundary.

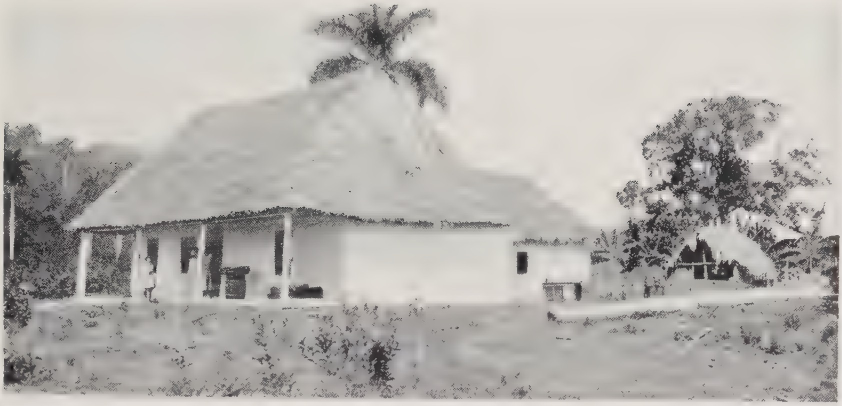

FIG. 13

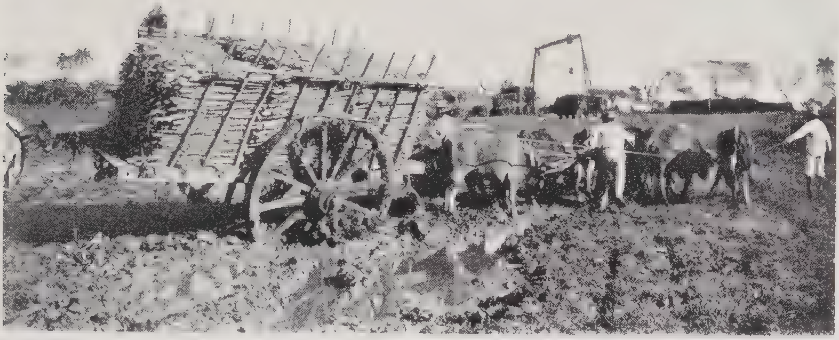

FIG. 14

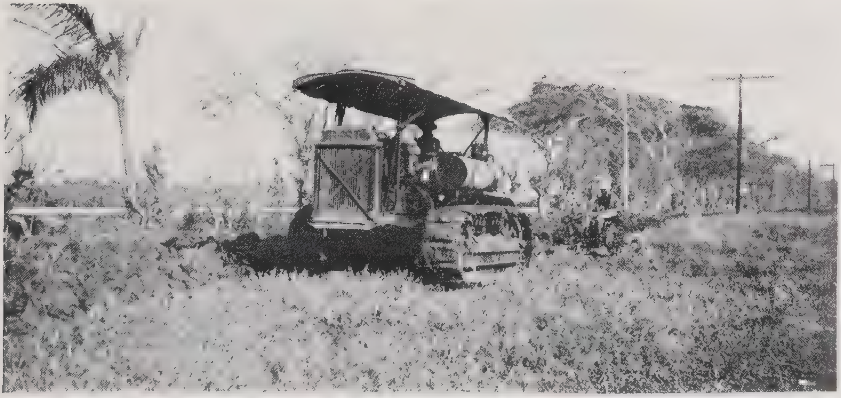

FIG. 15

FIG. 13—Rural house. Built of local materials; roof thatch of royal palm leaves and siding of royal palm trunks.

FIG. 14—Cane cart stuck in mud in wet weather. In background, cane scales, unloading oxcarts, and loading railway cars.

FIG. 15—Tractor breaking sod of temporary pasture for cane planting.

land occupancy. A narrow-gauge railway reaches out from the central to the cane lands of the district and to the port. Its function is not to supersede the old oxcarts but primarily to connect the plantations to the central. Oxcarts continue to be an efficient means of bringing in the crop from the fields; but, instead of delivering their load to the plantation mills, they take it to the near-by cane scales, which have replaced the mills on the plantations.

The system includes the cart roads giving access to every field and focusing on the cane scales. The roads of the Finca Mariel illustrate the arrangement. The cane fields themselves are made small, averaging six acres, and are separated by passageways for carts.

The cane of each *colono* goes regularly to the most convenient scales. The traffic divides between scales, along *colonia* boundaries, are crossed by few roads but by a single stream of traffic on the railway. At the scales producers make delivery to the central, and the railway system is within the central organization.

Form and Limits of the District

Whereas the size of the district is related to the capacity of the central, the form and limits of the district are related to the layout and limitations of the railway, which is designed to reach available cane lands.

Good cane lands extend at a higher level south of the escarpment; but the railway seeks cane lands in the lowland and avoids the inconvenient ascent. Cart roads, however, ascend the escarpment; and, within the range of oxcart haulage, cane is brought down from the edge of the upland. Extension of the district southeast in the upland is favored by a motor highway permitting truck transportation in place of railway transportation to the central.

Thus the boundary of the district cuts across cane lands in the upland. Here is the divide between the flow of cane toward Mariel and that toward other centrals, south, east, and west.

The details of the boundary, depending on land control, follow the borders of old plantations, with lines and landmarks fixed in past history. The escarpment is a physiographic boundary; but for the topic under discussion the border of the district is the geographic boundary. The opposite sides of the boundary are similar in land forms, soils, and climate, but different in location in a pattern of land occupancy.

Functional Movements of the Pattern

The significance of location depends on motion: the pattern moves, and in its dynamic as well as its static form it harmonizes with the natural setting. The rhythm of the seasons (see Table I) impels the major movements. Ground is prepared through the year for planting at the beginning or end of the rainy season. The cane grows through the rainy months. On fields just harvested it springs up again through the old leaves.

TABLE I—MEAN MONTHLY WEATHER DATA FOR MARIEL*

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Temperature (*degrees centigrade*)	20.9	21.0	22.5	25.0	25.4	25.9	26.3	26.6	26.1	25.2	23.0	21.4
Precipitation (*millimeters*)	17.6	54.6	45.5	56.9	128.3	191.2	142.6	169.4	169.5	199.0	79.8	61.9

* F. J. Velez: Geografía médico-sanitaria del Término Municipal del Mariel, Habana, 1927.

The operations of planting and cultivating, spread through the year or through several years, are leisurely compared with the great effort of harvesting the crop. Even when unrestricted legally, the harvest is confined to a period of little more than a hundred days in the dry season from December to April. The harvest begins at the end of the rainy season when the sugar content of the cane has increased to a point at which milling is profitable, generally above five per cent. It ends at the beginning of the rainy season when the difficulties of field transportation are too costly to make harvesting profitable.

The problem of harvesting northern hayfields is here multiplied many fold, by reason of the vastly greater product per acre, far harder to cut and hauled far greater distances. Oxcarts cannot operate in the mud, and it is difficult to devise any other economical method of wet-weather transportation. Even if tractors were obtainable, so numerous, so powerful, and so cheap that they could serve all the fields economically at all times, their use in the rainy season would be confined to a brief period before the decline of sugar content in the cane.

Harvesting in wet weather is complicated also by more rapid fermentation of cut cane, by greater injury to cane roots, and by greater difficulties and discomforts for field labor.

Confined to a brief period, the 16,000 acres of cane of the Mariel district are cut at a rate of over a hundred acres a day, by more than a thousand workers each cutting a ton and a half daily. The cane is transported immediately by more than a thousand oxen drawing two hundred and fifty carts, each taking daily two or three loads of three tons to the cane scales, to be carried on by a hundred cars to the central.

For a hundred days or more, work at the central is continuous. Day and night every ten minutes a carload is fed into the mill, or an oxcartload every two minutes.

The central is located to receive this inflow from the fields, and its location with reference to the outgoing product is less important—for only a fraction of the cane mass is transported away from the central. The water is boiled away; the crushed cane is burned for power and heat; a few cartloads of solid refuse are carried away to near-by fields as fertilizer; a small amount of liquid refuse runs to waste in a near-by stream; two or three truckloads of alcohol are sent daily to Havana; and the sugar product, about twelve per cent of the cane weight, leaves the central at a rate of one car every hour and a quarter, to be hauled to the port of Mariel and loaded, when ships come in, for export to the United States—seventeen thousand tons a year, about one half of one per cent of the sugar crop of Cuba.

Other Industries of the Mariel Pattern

The sugar industry forms only one part of the pattern of land occupancy at Mariel. Truck farming fits in with cane production. A fishing industry forms a distinctive pattern in the bay and streams and out in the Gulf. A great cement industry is concentrated in a little area of quarrying and manufacturing near the bay. A resort development extends along the shores, changing with the seasons. But these all belong in other chapters of the geography of Mariel.

NOTES ON A MAP OF THE LAGUNA SALADA BASIN, BAJA CALIFORNIA, MEXICO

Stanley W. Cosby
University of California

[With separate map, Pl. V, facing p. 620]

IN the northeastern part of the Mexican state of Baja California, almost adjoining the Imperial Valley, is the practically unknown Laguna Salada Basin.[1] While the two basins present close similarities of natural features, the dissimilarity between their economic development is notable. The Laguna Salada Basin is uninhabited; the Salton Sink has a population measured in tens of thousands. The one, occupying nearly a million acres, is practically unused; the other, slightly larger in acreage, has been the scene of one of the most rapid and spectacular developments in the whole history of irrigation agriculture. That important development has resulted in the creation of nearly $150,000,000 of property values with an annual production of agricultural commodities having a farm value of more than $25,000,000. Yet only thirty years ago the Imperial Valley region was a barren and uninhabited area, as the Laguna Salada Basin is today.

Of recent years Mexican officials interested in the economic advancement of their country have given much attention to reclamation possibilities. They recognize the need for thorough preliminary investigations covering not only the engineering aspects of the project under consideration but also other features that affect the economic success of such developments. The first investigation of this type was made in the Laguna Salada Basin during the winter of 1923–1924. Since that time a score or more similar studies have been conducted in connection with reclamation projects in other parts of Mexico.

One important phase of the investigation concerned the soils; the character of the various classes of soil was to be determined and the distribution of these classes plotted upon a suitable map. However, no such map, sufficiently accurate and detailed, was available; and the first need was for a survey of the basin and the preparation of a relatively detailed base map. In this work a closed transit and level traverse was made; beginning and ending at a known station in the city of Mexicali, this primary line extended longitudinally through the Laguna Salada Basin. From it, at intervals of three kilometers, secondary lines were run to the rougher areas at the base of the mountains. By aid of this grid the intervening topography was mapped by means of a plane table. From the plane-table sheets and other data acquired during the investigation, this article and the accompanying map, Plate V, have been prepared.

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[1] Although various names have been applied to this basin in the past ("Laguna Maquata" by the U. S. Geol. Survey; "Pattie" by Sykes, etc.) it has officially been designated as "Laguna Salada" in the General Map of Mexico (1 : 2,000,000) published in 1924 by the Mexican Government.

Physical History of the Basin

The Laguna Salada Basin, narrow and trough-like, is nearly separated from the main body of the Colorado River delta to the eastward by the Sierra de los Cucupas; on the north it is bounded by a high alluvial barrier along the International Boundary; and on the west and south by the rugged masses of the Sierra de Juarez and other mountains of the peninsular system. Like the thumb of a gigantic hand extending from the Gulf of California to the Salton Sea, the Laguna Salada Basin is connected with the main delta area at its southeastern end; at that point an eight-mile gap in the encircling heights opens toward the lower portion of the Hardy River, a distributary channel of the Colorado.[2]

The Laguna Salada Basin, like the near-by Salton Sink, is probably a former inlet of the ancient gulf that was subsequently dammed off by the advancing delta deposits. Alike in geologic history, these two basins have many physiographic similarities; the central area of each is composed of Colorado River alluvium, the gentle and almost imperceptible gradient of which extends downward from the delta distributary to a below-sea-level body of saline water at its northern end; in both, the central area is nearly surrounded by a wide band of sand dunes and piedmont slopes of coarser material that has had its origin in the adjoining mountainous regions.

Both of these basins, from a geological point of view, are of recent formation. Except for certain man-made obstructions—levees and similar works—the processes that have formed them would still be active. The Salton Sink, with these protective works, is no longer inundated; the Laguna Salada Basin without them is subject to periodic overflow. Whenever the river floods encounter the higher tides from the gulf, the Hardy River rises above its banks and a portion of its water flows down the sloping basin floor to the northern end. Although the inundations of the Laguna Salada Basin are relatively frequent, they vary greatly as to the time of occurrence and the volume of water that is diverted. Occasionally the basin floor is entirely covered with water; at other times the body of water has practically disappeared. These characteristic variations in the size of the Laguna

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[2] For a map of the Colorado delta see Godfrey Sykes: The Delta and Estuary of the Colorado River, *Geogr. Rev.*, Vol. 16, 1926, pp. 232–255.

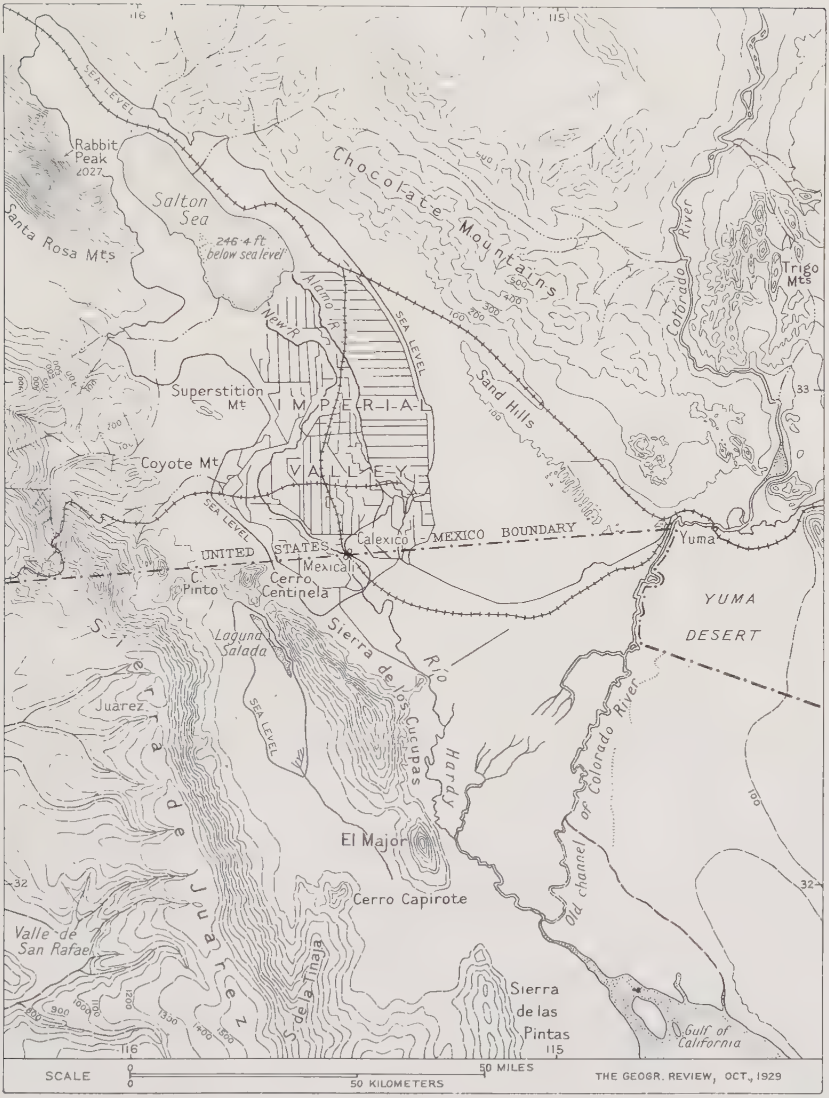

FIG. 1—Map showing the Laguna Salada Basin in relation to the Imperial Valley. The map is based in part on the Baja California-Norte sheet of the American Geographical Society's Millionth Map of Hispanic America. It is not possible to show the complete network of canals in the Imperial Valley, for there are 2000 miles of secondary canals in addition to three main canals; but its general character is indicated. Scale of map approximately 1 : 1,700,000.

Salada, as this body has been designated, have led some observers to differing and sometimes erroneous conclusions.

During the entire period of the writer's survey the greater part of the basin remained dry; the Laguna Salada had been reduced to a minimum size, and the central channel, or *barranca*, held but little

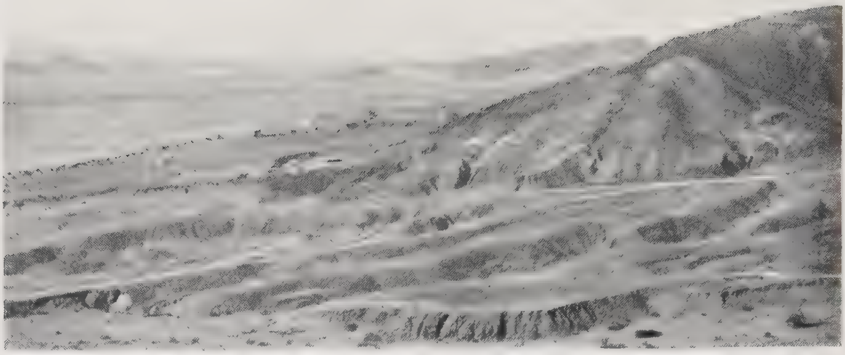

FIG. 2

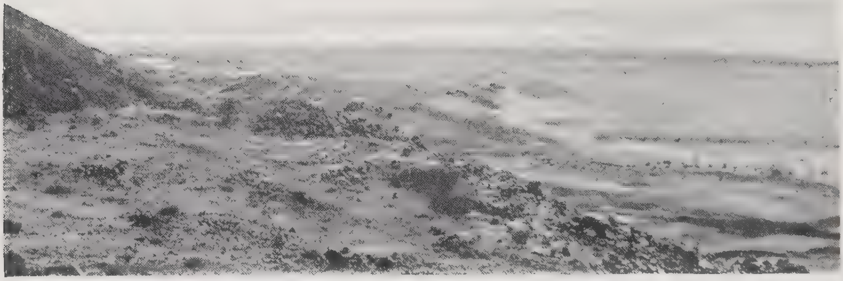

FIG. 3

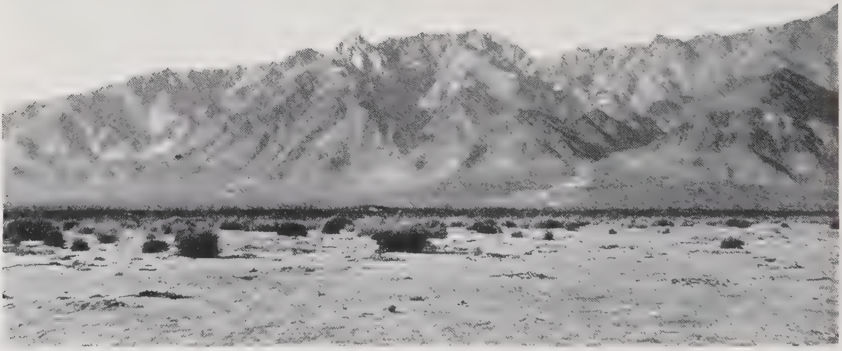

FIG. 4

FIG. 2—View westward across northern end of the Laguna Salada Basin. Note road and telegraph line connecting Mexicali and Ensenada passing down the smoother slope of the eroded fan. (Photograph by W. W. Weir.)

FIG. 3—Looking southward from the Mexicali-Ensenada road over the barren slope of the Sierra de los Cucupas, the eroded remnants of old alluvial fans, the vegetated piedmont alluvium, the smooth and barren area of Colorado River alluvium, the Laguna Salada. (Photograph by W. W. Weir.)

FIG. 4—Looking westward toward the base of the rugged Sierra de Juarez near its northern end.

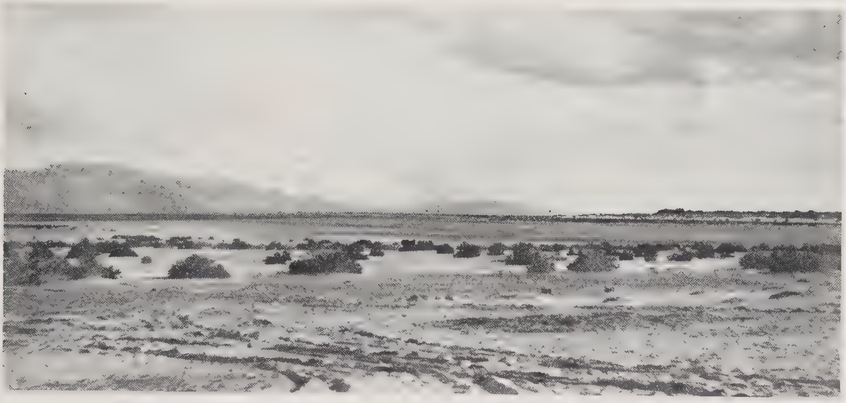

FIG. 5

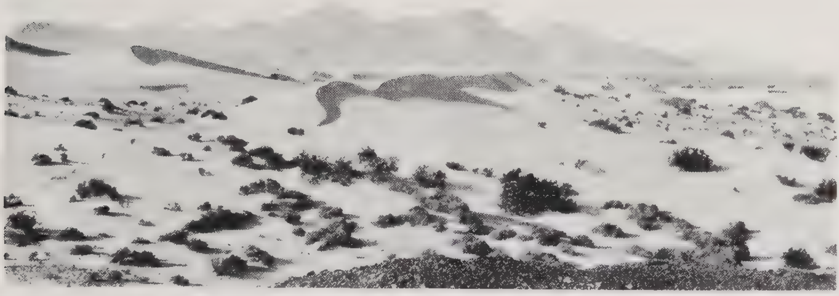

FIG. 6

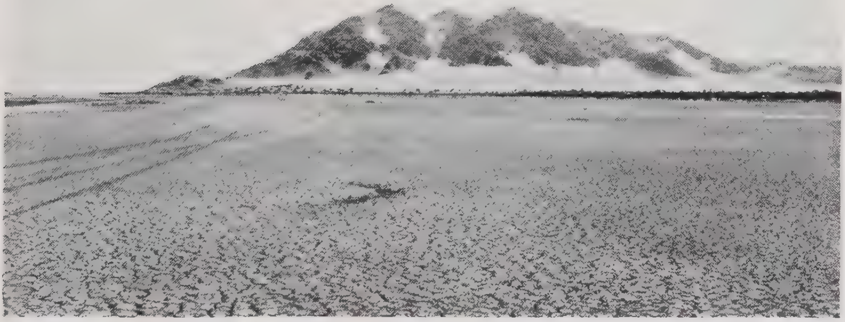

FIG. 7

FIG. 5—View southeasterly from camp at Pozo del Tule showing an "inlet" of the Colorado River alluvium and the encircling area of dune sand. Pickleweed in middle foreground; wingscale and mesquite on dunes in right distance.

FIG. 6—Crescentric dunes at base of Sierra de las Pintas. Plants are creosote bush and wingscale. (Photograph by J. S. Mejorada.)

FIG. 7—Looking southeasterly across the Colorado River alluvium toward the sand-mantled Sierra de las Pintas. (Photograph by J. S. Mejorada.)

water. Except for that fortunate circumstance, it would have been extremely difficult to secure much of the information regarding the basin floor, particularly its configuration.

TYPES OF LAND SURFACE

On the map, Plate V, four classes of land surface are recognized, exclusive of the bordering mountainous and rocky areas. They appear as irregularly sequential bands or areas with definite boundaries; in the field these areas are similarly distinct and definite, the chief exception to this being the boundary between the coarser deposits of the upper piedmont slopes and the finer materials on the lower slopes.

The most distinct and largest of these classes is the great central area of Colorado River alluvium. This extends from the southeastern end of the basin to within a few miles of its northern end, a distance of nearly fifty miles; nearly ten miles wide at either end, it is less than two miles wide at its central portion. This great body is practically free of vegetation, although along the *barranca* there is a narrow belt of pickleweed (*Salicornia ambigua*), arrowweed (*Pluchea sericea*), and cat-tail (*Typha angustifolia*). Along its western margin, from Pozo Cenizo northward, the wetter areas are marked by thickets of arrowweed and wingscale (*Atriplex canescens linearis*).

Around the margin of the valley floor are intermittent areas of sand dunes. These dunes are commonly ten feet or more in height; some in the southern part of the basin are extremely subject to wind action and have developed characteristic crescentic forms, although most of the dunes are capped with a mixed growth of wingscale, creosote bush (*Larrea divaricata*) and mesquite (*Prosopis juliflora*).

Above, and even between, these areas of sand dunes are the similarly intermittent areas of fine-textured piedmont materials. These have a gentle slope, with a fall of one to three per cent, marked by minor hummocks a few inches in height about the scattered clumps of vegetation. The characteristic vegetation of these areas is creosote bush, with a few wingscale, mesquite, and ironwood (*Olneya tesota*). As the upper limits of these areas are approached, the material becomes coarser, the gradient greater, and the creosote bush less dominant.

The upper piedmont slope comprises steeply sloping areas of coarse gravelly material and extends in an almost unbroken band along the base of the mountains. Near the canyon mouths, these areas are marked by the dividing and diminishing courses of ephemeral distributaries. These are stonier and coarser. They are characterized by a predominance of ironwood and paloverde trees, while the vegetation on the interfluvial areas includes ocotilla, cholla, and numerous cactoid forms, in addition to the creosote bush, wingscale, galleta, and other plants of the lower slopes.

The rugged mountain masses are chiefly granitic in character, although extensive exposures of basaltic and other basic igneous rocks occur in the southern part of the region. In the vicinity of Sierra de las Pintas some sedimentary and metamorphosed rocks occur, while in the northern part a small butte at the base of the Sierra de Juarez was composed, in part, of limestone. Exfoliation and weathering has been active, and the torrential rains have cut deep canyons. Except for a few isolated group of native palms (*Washingtonia filifera*) situated in more favored spots, these barren slopes are marked only by an occasional, struggling cactus.

Trails and Water Supply

A few words regarding the condition of the water holes and trails may well be added for the guidance of the visitor unfamiliar with this desert basin. With the exception of the Mexicali-Ensenada road across the northern end of the basin, there are no regularly trav-

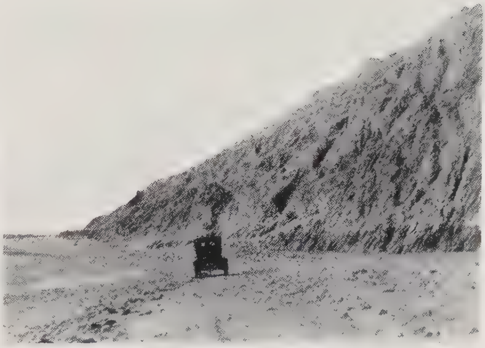

Fig. 8

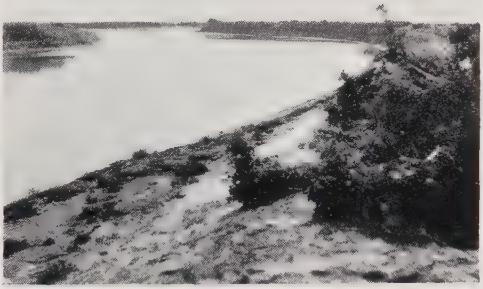

Fig. 9

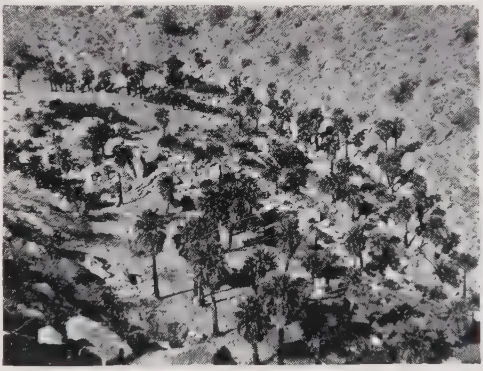

Fig. 10

Fig. 8—Shore line of the Laguna Salada at base of the Sierra de los Cucupas; note high-water marks on rocky wall at right.

Fig. 9—Looking southerly along the channel in the central part of the basin: trapped in this eight-mile channel the overflow water slowly evaporates. (Photograph by W. W. Weir.)

Fig. 10—Looking down upon one of the larger groups of native palms (*Washingtonia filifera*) at Las Palmas.

eled roads. Of the trails in the central part of the basin the easternmost was a temporary track made by a transient fisherman who netted mullet in the waters of the *barranca;* the middle one was a low-level trail followed by the truck that plied between the La Vinata distillery and Mexicali; and the westernmost, passing near Las Palmas, is simply the distinguishable portion of the high-level trail of this same truck. At the southeastern end of the basin is a short part of the La Bomba trail, connecting Mexicali with the tiny gulf port of that name. From the La Bomba trail to the Tres Pozos water hole is a route commonly followed by the cattle drivers from more southern localities on their way to Mexicali. This is connected with the La Vinata trail by a very poorly defined track that passes near Pozo Coyote and Pozo Cenizo.

Although, when dry, the smooth hard surface of the Colorado River alluvium makes an excellent roadbed, when wet either by flood waters or rains it is soft and impassable; at such times travel is confined to the surrounding piedmont slopes, and the lower trails are obliterated.

Except for the Pozo del Tule, in the northern part of the basin, and at Las Palmas, there are no dependable supplies of potable water in the basin. The water holes around the margin of the relatively impervious Colorado River alluvium are shallow pits excavated in localities of high water table. In contrast to the others, Pozo del Tule apparently has a never-failing supply of water, the water welling over the top of its wooden sides.[3] In case of dire necessity, the traveler possibly could secure a temporary supply of water by digging along the western margin of the valley floor where a fresh growth of arrowweed suggested the presence of a relatively high water table.

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[3] At the time of these investigations a small trout-like fish (one to five centimeters in length) was darting about in the water of the Pozo del Tule. Although no specimens were collected, it is believed that these might be *Lucania brownii*, found by MacDougal in a warm spring on the opposite side of the basin in 1907 (D. T. MacDougal: The Desert Basins of the Colorado Delta, *Bull. Amer. Geogr. Soc.*, Vol. 39, 1907, pp. 705–729).

EXPLORATIONS IN COLOMBIA

F. O. Martin

[With separate map, Pl. VI, facing p. 636]

"SETTLED but unexplored" is a phrase which in all of the West Coast republics of South America aptly characterizes many large areas that have had a considerable population for generations. It is particularly applicable to the countries north of Chile. Cartography has not kept pace with the settlement and economic development of these countries. The reason is not far to seek. Their physiographic make-up has prevented that steady pushing back of the frontier on a broad front that has been characteristic of the United States. Instead, encroachments on the frontier have taken place in widely scattered sections for the exploitation of the most easily developed natural resources. As long as these developments consisted of mining carried on in limited areas by more or less primitive methods and of agriculture of the frontier type, detailed mapping or in fact mapping of any sort was not required.

The introduction of foreign capital and modern methods of study and exploitation, particularly in the search for and development of petroleum-yielding regions, has resulted in the reconnaissance mapping of many extensive areas and much detailed topographic survey. In the last fifteen years American and European petroleum companies have covered thousands of square miles, particularly in Colombia and Venezuela, with high-grade topographic surveys. The reconnaissance surveys which preceded them cover much larger areas. Few of them, however, ever find their way into the hands of cartographers engaged in the production of general maps, because it is only rarely that information concerning them is published in the geographical and geological periodicals which are the cartographer's chief source of information as to new surveys. They are, moreover, mainly of confidential nature and therefore not easily obtained. They form at present the most important source of accurate material for compiled maps of these two countries. No compilation which does not include them can be considered as representing our present cartographic knowledge of these countries.

THE AREA EXPLORED

I spent about one-half of my time from June, 1920, to February, 1926, in the upper Guayabero River system and the upper parts of the Balsillas and Pato rivers, in the little-known region of the Eastern

Cordillera of the Andes and the western border of the llanos south of Bogotá. Since the objective was the mapping of lands owned by the Union Oil Company of California and the determination of their geological character, exploration was limited to the areas necessary for the carrying out of this purpose. The results are shown on the map, Plate VI, facing p. 636.[1] It is obvious that much exploration and mapping remain to be done before the topography of the region is completely known. Previous to my exploration, however, the region was practically unknown cartographically, and current maps show its topographic features so erroneously and so confuse the nomenclature of them that they are only a handicap to the explorer. Some notes on the topography accompany the map, and I shall precede them with a brief description of the region in general.

From the Magdalena to the Llanos

From the Magdalena to the llanos in the area covered by the map five climatic belts may be recognized running roughly parallel from north to south. On both sides of the Magdalena is a strip of more or less flat lands of varying width with a desert vegetation. The occasional rainfall that occurs there is torrential. This desert strip is narrower on the east side of the river than on the west. In fact, south of Natagaima and also near the mouth of the Rio Sumapaz the foothills of the Cordillera Oriental extend to the Magdalena.

As one goes eastward into the foothill region the vegetation gradually changes, and at 700 meters elevation the *templada*, or coffee country, as it is commonly called, is reached. The climate there is delightful as far as temperature is concerned, but the rainfall is heavy. The *templada* extends to an average elevation of about 2000 meters and in places still higher. Within this belt, above and below the junction of the Ampica and Cabrera rivers, is a typical desert region—its center being the village of Columbia—where it rarely rains and where the temperature is warm, though not excessively so, throughout the year. The "cold country" begins on the west side of the cordillera at about 2000 meters, although in the narrow river valleys of the interior of the cordillera its lower limit extends to 1700 meters. There is no plateau region south of the Sabana de Bogotá and no *páramo* region south of the Sumapaz mountain complex.

On the east side of the cordillera the cold zone is much narrower than on the west side, particularly south of the Sumapaz complex, and the *templada* is correspondingly wider and extends down to 500 meters above sea level. North of the Río Guejar and extending northeasterly into Venezuela the llanos stretch away for hundreds of miles unbroken by any tree growth except moriche palms near lagoons and gallery forests bordering the creek and river courses. South of the Río Guejar and the lower Río Ariari to its mouth in the Guayabero is a sandstone plateau which reaches to elevations of 1500 meters and is practically unexplored. Along my route I found it covered with virgin forest. Farther south, however, on the Mesa de Yari and probably also on the Mesa de Pardaos, llanos conditions again exist according to what I believe to be reliable information.

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[1] Credit is due the Union Oil Company of California, which paid for all of this work, for permission to publish the geographical results. The company has also contributed the original surveys on which the map which accompanies this article is based for compilation into the Bogotá and Cali sheets of the American Geographical Society's Millionth Map of Hispanic America.

Settlements in the Cordillera Oriental and in the Llanos

There is a considerable population between Chipaque and Quetame along the Bogotá-Villavicencio road. Cáqueza, the largest town, with a population which I estimate at somewhat over 8000, is picturesquely situated high above the right bank of the Río Cáqueza. The inhabitants of the district are chiefly of mixed white and Indian blood. They are distinctly mountain types, short and stockily built and of great endurance. From Quetame on toward the llanos one encounters mainly isolated houses, although in places as many as a dozen may be found grouped together. Villavicencio, the capital of the Intendencia del Meta, is a growing town with an estimated population of 6000 to 8000. It stands on the western border of the llanos, and here one notices a change in the appearance of the people. Although there is still a considerable element of the mountain type, the majority of the inhabitants are whiter, taller, and more slender. These characteristics increase as one advances farther into the llanos, and the mountain types gradually disappear.

Of the llanos very little is known even by Colombians. Much less is known of them now, in fact, than at the end of the Spanish régime. Certainly they had then a much larger white and mixed population than now and furnished pastureland for thousands of head of cattle. During the War of Independence and the long succession of civil wars that followed the establishment of the republic the herds were broken up and the ranches and settlements largely deserted. The picturesque llanero, the Colombian counterpart of the gaucho of the Argentine Republic and Uruguay, has completely disappeared. Whole villages of the colonial period seem to have vanished. For instance, three maps executed by Francisco Requena in connection with the dispute between Spain and Portugal over the extent of their respective territorial rights in South America and dated September 1, 1779, April 1, 1783, and July 1, 1788, all show the village of San Juan de los Llanos, which I assume was located where the village of San Juan de Arama was later founded between the Acacias and Malpaso quebradas. I have seen in the village of Mesetas, a short distance west

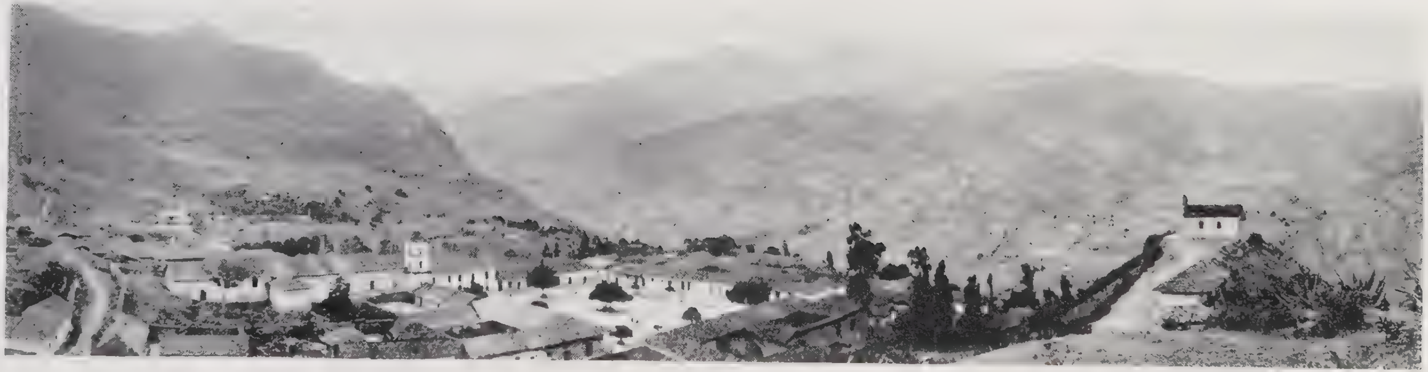

FIG. 1

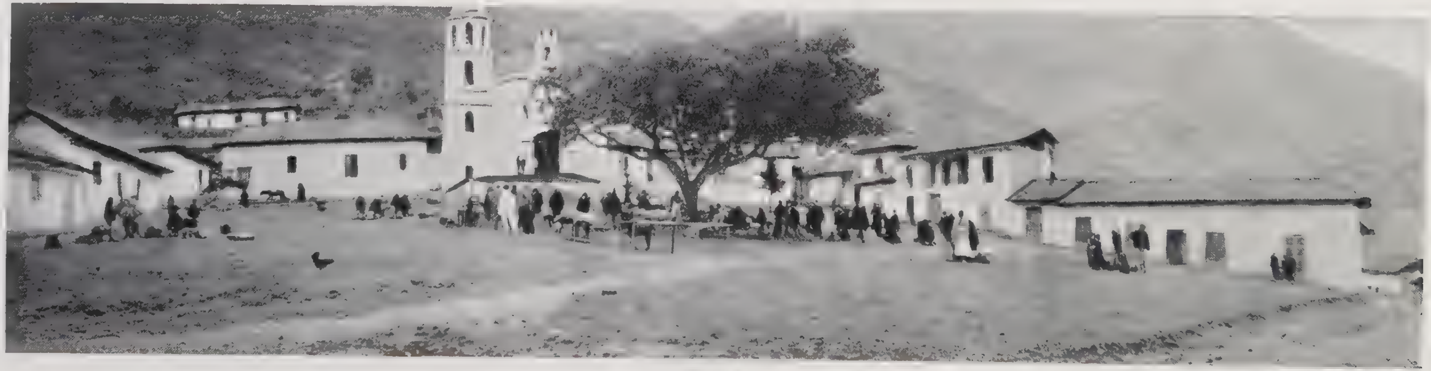

FIG. 2

FIG. 1—Cáqueza (altitude 5150 feet), the chief town of the *templada* zone east of Bogotá. View looking northwest.
FIG. 2—The plaza of Quetame, another town of the *templada* zone.

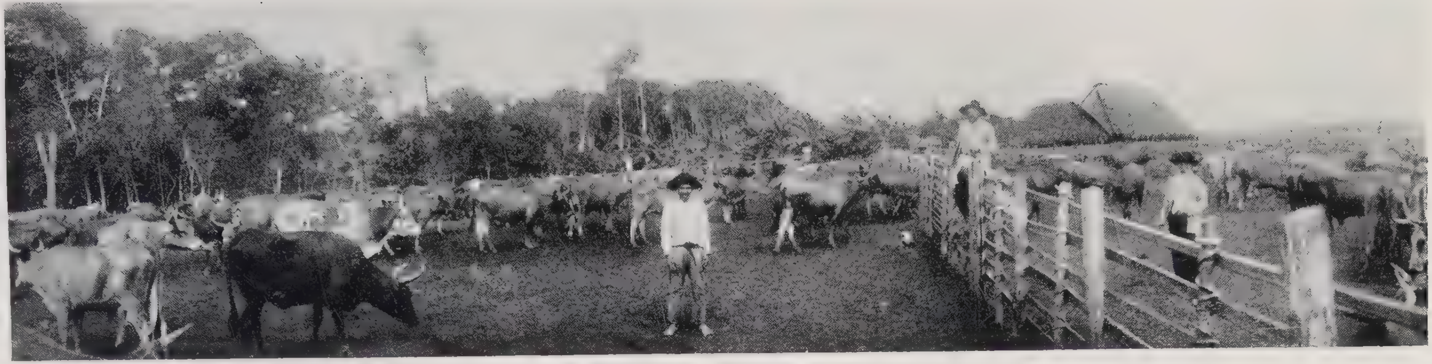

FIG. 3

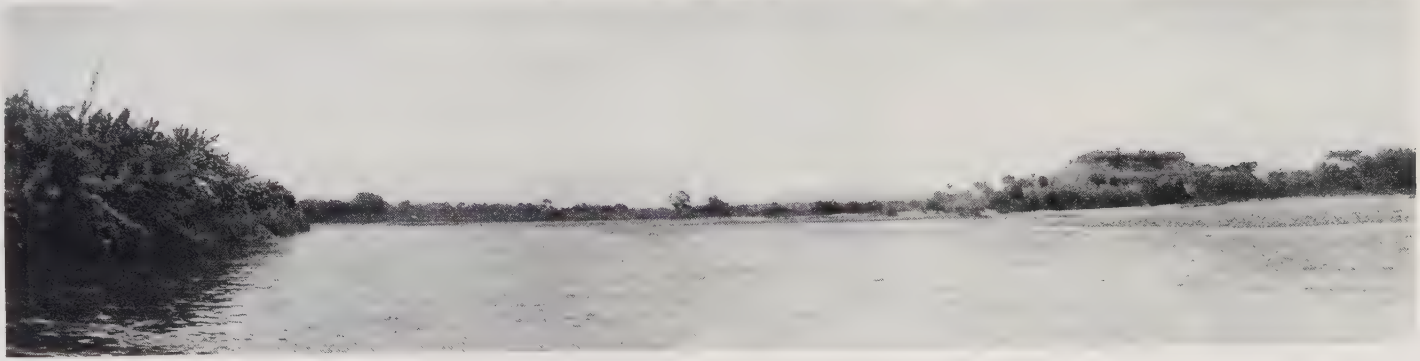

FIG. 4

FIG. 3—Scene on a cattle ranch on the llanos near San Martín.
FIG. 4—The Río Guayariba between Villavicencio and San Martín.

of this location, an old church bell bearing inscriptions up to the eighteenth century that had come from San Juan de Arama. The spot where this village stood is now covered by the jungle.

The only settlements of any consequence south of the Bogotá-Villavicencio road are San Martín and Uribe. San Martín has a notoriously and deservedly bad reputation on account of its high rate of mortality.[2] When I last passed through the town in August, 1924, a so-called *pesta*, epidemic, was at its height.

Uribe, near the upper Río Duda on the Columbia-Uribe-San Martín trail, consists of the usual plaza with two short streets leading off from each corner. There are in all perhaps forty houses, a church, a school, and a jail. This village has a history somewhat typical of the changes and vicissitudes that characterize the majority of the settlements of the eastern flanks of the Andes and the llanos border. It was established in the eighteen-seventies, when the trail from Columbia to the Llanos de San Juan was built, and was named after Francisco Antonio Uribe, an energetic native of Antioquia who was the first Colombian really to attempt on any large scale the development of the immense resources of the region. He and his associates were first engaged in the quinine bark industry. At times they employed thousands of laborers and at first acquired lands on the west side of the Cordillera Oriental for the breeding of pack mules for transporting cargoes across the cordillera and of cattle to feed their employees. It was found that the west side properties were insufficient to supply the demand. Properties were therefore acquired in the llanos, and a road was opened across the main range of the cordillera at its lowest point, the Paso de las Cruces. To provide halting places and pasture for the cattle on their way from the plains, more lands were acquired on the Tigre, Papamene, and Duda rivers, and the settlement of Uribe was founded. After the fall in the price of quinine in 1887, Uribe and his associates turned to the extraction of rubber and the raising of cattle for the market. These two enterprises were apparently very profitable for some years; but the civil war of 1899–1902 made it impossible to supervise the work. Nearly all of the cattle were stolen, and the rubber collectors were all engaged in fighting. It is reported that before the revolution there were 14,000 head of cattle in the Llanos de San Juan.

After the civil war rubber collection was resumed and continued until 1912, when the price of rubber dropped to a point where it was no longer profitable. Some quinine plantations were established near the western side of the Paso de las Cruces, and rubber trees were planted near some of the affluents of the Río Duda; but they were abandoned because of lack of cheap labor—in fact, of any labor at all. While the quinine and rubber exploitation was going on much land was cleared for the growing of agricultural products for food for the laborers. Coffee and cacao plantations were also established. Many of the inhabitants left when the quinine and rubber markets failed. Those that remained gradually spread out along the Río Duda and its affluents and made a number of clearings where plantains, cacao, coffee, maize, yuca, and tobacco are grown. Their only exports now are small quantities of cigars and cacao and a few pigs and cattle. All agricultural products adapted to the region grow in great abundance, and the inhabitants could live a very contented life if it were not for their trading and hunting propensities. Instead of attending to the work on their clearings the men will waste days to make some sort of trade and will travel long distances over wretched trails to take a few dollars worth of cigars or a pig or cow to the market at Columbia or San Martín.

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[2] Compare Hamilton Rice: Further Explorations in the North-West Amazon Basin, *Geogr. Journ.*, Vol. 44, 1914, pp. 137–168.

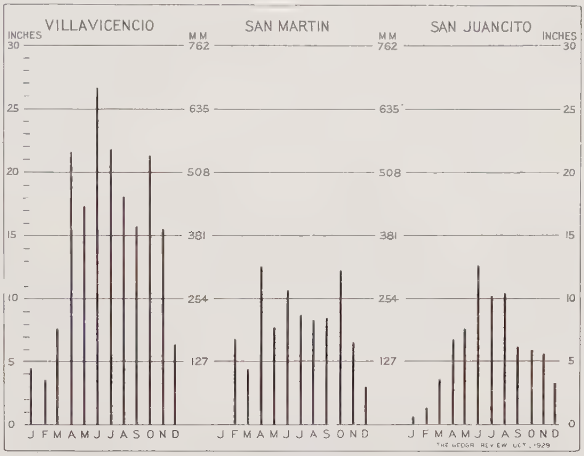

FIG. 5—Graph of monthly rainfall (average for 1925 and 1926) at stations in the Intendencia del Meta, drawn from data furnished by Dr. Sarasola, Chief of the National Observatory at Bogotá.

Whereas on the west side of the Cordillera Oriental there are two dry and two wet seasons, fairly well defined, on the east side there is only one wet and one dry season, the latter beginning in December or January. The rains, however, usually abate somewhat in August, and a so-called *verancito* (little summer) lasts for about thirty days.

From Puerto Crevaux down the Río Guayabero and from La Julia down the Río Duda there are no settlements, and not even isolated houses are encountered until one reaches the junction of Río Ariari and the Río Guayabero. There are very few Indians in that part of the llanos covered by our surveys—none at all in the villages mentioned above. Each year some twenty men, women, and children of the Guahibo tribe from near the lower Ariari visit the settlements on the Llanos de San Martín. They do not come to work but camp beside the streams, do some fishing, make pottery, and trade a few hammocks for cotton cloth and trifles of various sorts.

The whole region of the eastern border of the Andes and the llanos offers unusual opportunities for agricultural development as far as soil and climate are concerned. Coffee can be grown profitably. Cacao is a less certain venture on account of diseases which affect the trees. The llanos are admirably suited to cattle raising on a large scale. Grass grows nearly everywhere to knee height, and there is an abundance of running water and many lakes and ponds, while the strips of forest that line all the streams furnish shade.

Three chief drawbacks to the settlement and development of the region are the lack of kept-up roads and trails and the lack of a good labor force. There is no community spirit among the inhabitants in the matter of maintaining trails or in any other communal relations. Coöperation is unknown; rather, intense jealousy among individuals prevails. Very few trails are laid out according to the approved practice of following the contours in gentle gradients. Most of the trails go straight up the mountains and steeply down the other side. Horses are practically useless on these trails, and even mules cannot stand continuous travel on them for more than a week at a time. In the rainy season better time is made on foot. Even the so-called *camino nacional* between the town of Columbia and the Llanos de San Juan is at best only a miserable trail.

The present inhabitants from which the labor supply must be drawn are shiftless and rarely stay in one place long enough to establish a home. They cannot be depended upon to work steadily. Very few can be secured to work for more than a week at a stretch. The result is that the only paying industry of any proportions since rubber exploitation ceased is cattle raising, which requires little labor in proportion to the capital invested.

Topographic Notes: The Cordillera Oriental

The Cordillera Oriental south of Bogotá is one of the least-known parts of the whole Andean chain. This section has none of the high savanas with their rich soil and dense population which characterize the cordillera from Bogotá northward. It has not been to any extent explored for mineral resources nor has it heretofore been the subject of physiographical or geological studies except for the work of Hettner,[3] who in 1882 carried his investigations as far south as the latitude of the Río Fusagasugá.

The valley of the Magdalena there narrows, and the crest of the cordillera which forms the main divide between the Magdalena and the Orinoco system approaches much closer to it than farther north. Southward from the Páramo de Sumapaz this crest lowers rapidly until at the Paso de las Cruces at the headwaters of the Papamene branch of the Río Guayabero its elevation is only 6147 feet—the lowest pass in the Cordillera Oriental south of Bogotá and, I believe, considerably lower than any pass farther north. The lowest pass in the

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[3] Alfred Hettner: Kartographische Ergebnisse einer Reise in den Columbianischen Anden, *Petermanns Mitt.*, Vol. 34, 1888, pp. 104–112; *idem:* Die Kordillere von Bogotá, *Ergänzungsheft No. 104 zu Petermanns Mitt.*, 1892.

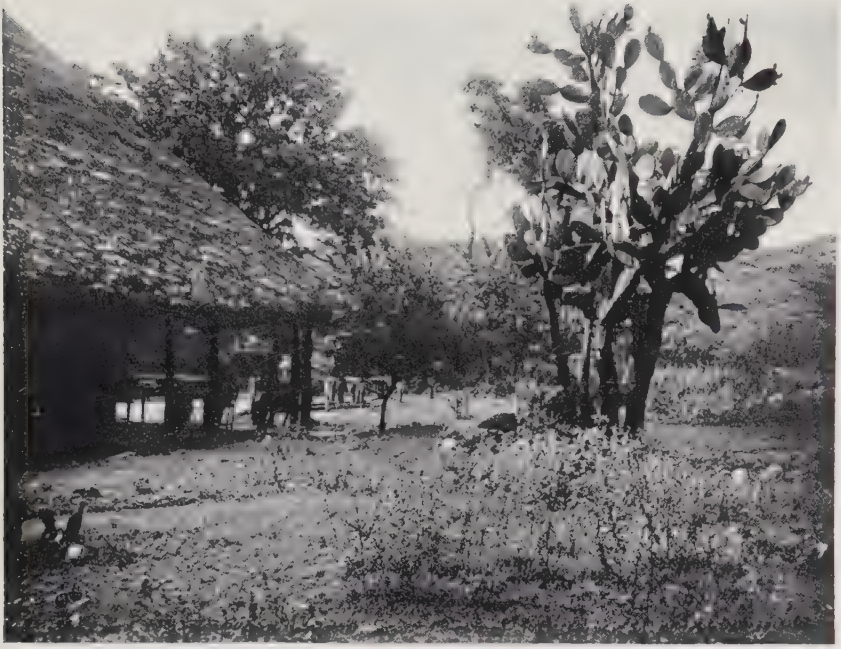

FIG. 6

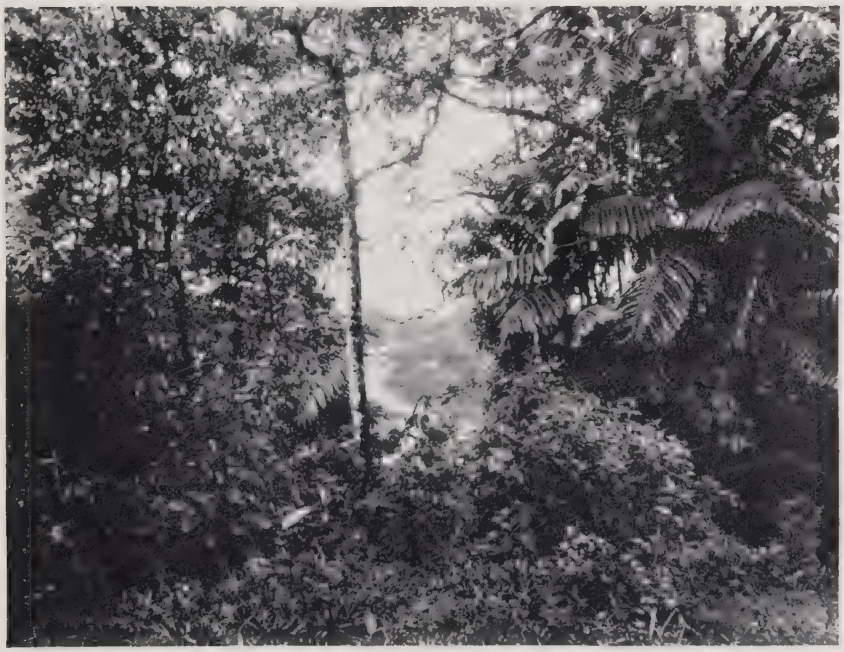

FIG. 7

FIG. 6—Desert vegetation in a dry pocket of the Río Cabrera valley, on the western side of the Cordillera Oriental.

FIG. 7—The Río Papamene, tributary of the Guayabero, seen from the northwest.

vicinity of Bogotá is 9932 feet according to our measurement, and the Paso de Santa Lucia at the headwaters of the Río Fortecillas is 8302 feet. The pass between Andalucia and Florencia, near the Río Caquetá, is reported as 7872 feet.

Hettner[4] has called attention to the fact that most of the rivers of the Cordillera Oriental flow at first in longitudinal valleys with a general north or south direction parallel to the main ridge of the cordillera. His explorations, however, did not extend south of the Río Fusagasugá. We found his observations to be true on the west side of the cordillera north of the Río Cabrera. Farther south, however, most of the rivers flow in transversal valleys except for short distances from their sources. On the eastern side of the cordillera the Río Negro (as the upper course of the Río Guayariba is called) flows in a longitudinal valley until it breaks through to the llanos; but the Ariari, Guape, and Guejar flow for the greater part of their courses in transversal valleys. The Tigre and the Papamene flow southward in longitudinal valleys, as does also the Guayabero from Puerto Crevaux to a point near the mouth of the Duda. The Duda flows south-southeast in a transversal valley.

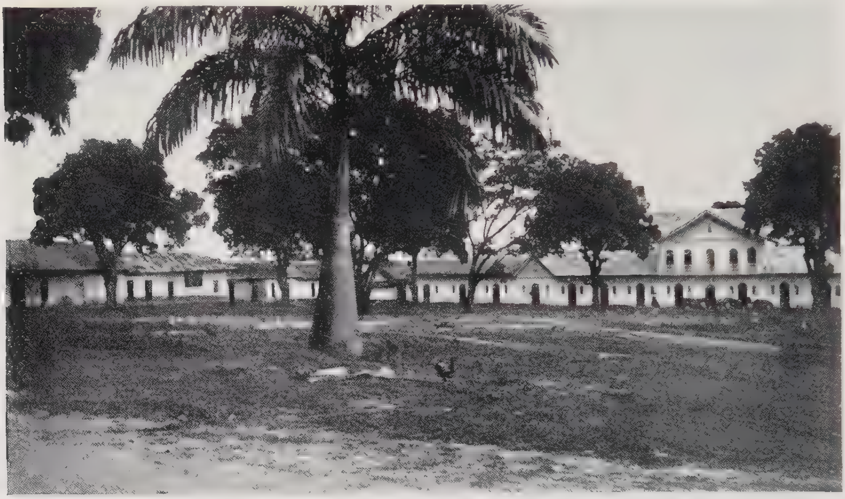

FIG. 8—The plaza of Villavicencio, capital of the Intendencia del Meta.

THE LLANOS

The Llanos de San Juan, formerly called the Llanos de San Juan de Arama, lie between the Río Guejar and the Río Ariari. They are distinguished from the Llanos de San Martín, which lie farther north between the Río Ariari and the Río Humadea, by their greater elevation—they average 300 feet higher—and their more luxuriant vegetation. The grasses grow better there than in the Llanos de San Martín and are said to furnish better pasture for cattle; and the gallery forests which line the quebradas and *caños* are thicker and wider. Two table mountains, the Mesa de Yamen, which lies somewhat isolated between the flood plains of the Ariari and the Guape, and the Mesa de Fernando between the Guejar and the Guape, form the western border of the Llanos de San Juan. It was probably these that Dr. Rice identified as the Cordillera de Macarena.[5]

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[4] Hettner: Die Kordillere von Bogotá, p. 41.

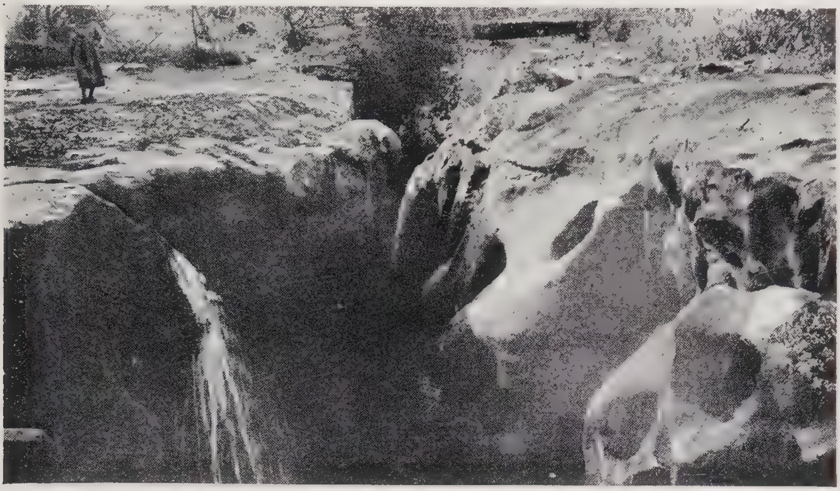

FIG. 9—Caño of the Quebrada Las Penas, a stream cutting through the sandstone Cordillera de Macarena.

The Sandstone Cordillera de Macarena

The Cordillera de Macarena is in fact an extensive sandstone plateau. The Río Guejar, after leaving the cordillera proper, flows along its northern edge. The Guayabero enters it below the mouth of the Río Duda. Dr. Crevaux[6] gives graphic descriptions of two *angosturas*, or rapids, on the Guayabero in its passage through this cordillera before it reaches the Ariari. He describes the first as varying in width from 39 to 82 feet and as being 1⅕ miles long with walls 150 feet high. It is apparent that the cordillera extends across the Río Guayabero to the south. Its southerly extension is very likely represented by the Sierra Chiribiquete shown on Dr. Rice's map. Dr. von Bauer[7] calls the dissected plateau country between the Sierra

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[5] *Op. cit.*, p. 143 and map.

[6] Jules Crevaux: Voyages dans l'Amérique du Sud, Paris, 1883.

[7] Peter-Paul von Bauer: NW-Amazonien: Ein Beitrag zur Geographie Aequatorial-Amerikas, Inaug. Diss., Brünn, 1919.

Chiribiquete and the Cordillera de Macarena the Mesa de Pardoas, and, from his description of the latter, I believe it to be identical in character with the Cordillera de Macarena.

The Cordillera de Macarena has never been crossed between the Río Guayabero and the north of the Río Duda on the south or between the Río Guejar and the Río Ariari on the north. Even the rubber gatherers, formerly rather numerous in this territory, failed to cross it, although an expedition tried it once in search for a shorter route between the Llano de San Juan and the Río Guayabero. I twice attempted a crossing from the Río Duda above La Julia, as the map shows, but was turned back not only by the impassable chasms but also by the failure of provisions both at the point and at the base on the Río Duda. From what I have seen at a distance from the northeast, north, and west, I believe the whole region to be a sandstone plateau weathered into the present fantastic forms which led the early Spanish and German explorers to imagine that they were the spires and turrets of old cities—the ever-searched-for El Dorado with its golden treasures.

The top formation is of massive, cleft, whitish-yellow quartzose sandstone over 600 feet thick. This sandstone has become very porous through the washing away of its cementing materials by the heavy rainfall of the region. The isolated peaks, towers, and columns are due to the difference in the size of the sandstone particles and the amounts of cementing materials. Throughout the entire formation is a system of joints and fissures perpendicular to the sediments and crossing each other at right angles. The fissures, which have the same easterly slope as the formation itself, are particularly well-defined and in places have been eroded six feet wide and 200 feet deep. The steep sides of the plateau usually have a dark, shiny, hard surface, which gives the rocks an appearance of volcanic origin that is not disproved until the surface is chipped off. This protective crust, called tropical gloss, is the same as the desert varnish of the North American deserts and is produced by the mineral solutions within the rock coming to the surface through capillary action and the through-heating of the upper rock layers.

The fact that the Caño Grande branch of the Río Inirida and the Río Uaupés have their sources to the east end of the Mesa de Pardoas and that the Guayabero seems to be the only river large enough to have broken through the Cordillera de Macarena, leads me to believe that the Balsillas and Pato rivers are not affluents of the Río Guayabero but have been forced by the Cordillera de Macarena or its southern extension into a southerly course and are, therefore, a part of the Caguan-Caquetá-Yari-Caquetá system; that is, they pertain to the Amazon drainage. This opinion is strengthened by various reports, among which is a report made to the Colombian government by the Comisario de Caquetá, May 31, 1925, in which it is stated that the Río Caguan is identical with the river called Balsillas at its source and that the Río Pato is the source of the Río Yari.

In the bed of the Río Guejar west of the Llanos de San Juan, the flat-lying formations of the Cordillera de Macarena lie unconformably over banks of hard shale, quartzite, and arkose, which dip 80° south and 55° east; its outcrops having been truncated almost level as far as they could be seen from near the river banks. The difficulty of doing geological work in this tropical region is illustrated by the fact that I had been near this place four times in different years and did not discover this unconformity till 1926 when the river was very low. At other times the underlying formations were deep under water and on the shores covered by gravel banks and detritus. It is apparent that the extensive sandstone plateau from the Río Guejar southward is distinct from the formations and structure of the Cordillera Oriental. Studies of this feature are still under way.

As Bauer has indicated, the surface of the plateau becomes more uniform the farther one travels west from the headwaters of the Caño Grande and the Unilla and Itella rivers. I have had similar information. Moreover, the plateau some distance east of the Río Caguan is called the Llanos de Yari; and the fact that within the last few years a cattle industry has been developed in these llanos would indicate that they cannot be so broken and covered by dense forest vegetation as are the Cordillera de Macarena, the Mesa de Pardoas, and the Sierra Chiribiquete.

Principal Rivers: Affluents of the Río Meta

My expedition crossed all of the left bank tributaries of the Río Meta down to the point where the main stream is known as the Meta. We found the nomenclature of these streams as they appear in previous maps and descriptions very misleading. The name of even the main stream varies from place to place; and the Río Humadea, which is given by most cartographers and writers as the principal headwater affluent of the Meta, was found to carry much less water than the Guayariba. The name of the latter changes to Río Negro above the bridge on the trail from Villavicencio to San Martín, as shown on the map; while the name Río Negro is also given to a stream which has its source 3½ kilometers east of the bridge and is called Candelaria for a short distance from its source. During a part of the rainy season part of the water from the Río Guayariba flows into the Candelaria, and the latter is called the Río Negro downstream from the point where it receives this overflow. Stübel[8] describes the Río Negro as emptying into the Río Guataquia. The Guataquia, however, unites with the Río Umea about ten miles west of the mouth of the Río Negro in the Río Umea, and the latter continues as the Umea to the point where it joins with the Río Humadea to form the Río Meta. It would be well if the names Guayariba and Río Negro (as applied to the Upper Guayariba) could both be abolished and the name Meta applied to the whole stream from its source.

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[8] Wilhelm Reiss and Alfons Stuebel: Reisen in Süd-Amerika: Geologische Studien in der Republik Colombia (3 vols., Berlin, 1892–1899), Vol. 3, p. 119.

Affluents of the Río Ariari

The rivers shown on our map as entering the Río Ariari from the north before the latter reaches the llanos were taken from information given by Ricardo Lleras Codazzi[9] and also from surveys made by Colombian engineers some fifty years ago of land now owned by the Union Oil Company. From experience in checking other surveys derived from similar sources, I am sure that these surveys are only approximate. The Río Iraca enters the flood plain of the Río Ariari at El Porvenir and probably flows nearly parallel to the Ariari for some miles before joining it. Eastward from San Martín I explored the water divide between the Ariari and the Meta and believe that I reached the sources (not mapped) of the Caño San Vicente of the Ariari drainage basin and of the Río Manacacias of the Meta basin. It is reported that the portage between these two streams is only six miles.

Our examination of the southern affluents of the Ariari was much more thorough and proved the complete inaccuracy of the official Colombian maps. The principal southern tributary is the Río Guape, which unites with the Ariari at the point where the latter is crossed by the trail from San Martín to the Llanos de San Juan. I was informed that up to 1917 the mouth of the Guape was some five miles farther upstream. At present it enters a broad flood plain about 16 miles from its mouth and divides into numerous branches, all of which finally reach the Ariari.

The next largest southern tributary of the Ariari is the Río Guejar, which has its source in the Páramo de Sumapaz. It flows first in a southerly direction as far as the village of Mesetas, where it is turned eastward by the Cordillera de Macarena. Thence it flows for some distance along the northern end of the cordillera and, then entering it, flows between banks several hundred feet high, first easterly, then southerly, and finally southeasterly. At Mesetas the river is 160 feet wide and can usually be forded diagonally by sending men into it to find the shallowest places. In the llanos between the Ariari and Guejar are a number of quebradas which contain considerable water and can be navigated in *canoas* for some miles from their mouths. Of these quebradas, Acacias and Honda flow into the Río Guejar, and the Cunimia into the Río Ariari. The divide between the Ariari and the Guejar was not examined but is doubtless the series of low hills, *serranías*, which we observed from a distance. The Guejar is essentially a mountain stream with a considerable fall and is eroding vertically, while the llano streams such as the Acacias, Honda, and Cunimia have little fall and are eroding laterally.

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[9] Ricardo Lleras Codazzi: Reseña Geológica del departamento de Cundinamarca, Cordillera Oriental de los Andes Colombianos, *Proc. Second Pan Amer. Sci. Congr., Washington, U. S. A., December 27, 1915, to Jan. 8, 1916*, Vol. 8, Section 7, pp. 351–362; and Notas mineralogicas y petrográficas, Museo Nacional, Bogotá, 1925.

Drainage System of the Río Guayabero

We ascended and mapped a section of the Río Guayabero to a point somewhat less than three miles from Puerto Crevaux, the name given to the place where Crevaux on October 25, 1861, started on his remarkable trip down the river to its mouth in the Orinoco. Only cinchona bark gatherers have ever reached the sources of the Río Guayabero, and, since no cinchona bark has been gathered for more than forty years, I found only one man who had been over the route. Our surveys, however, prove that on all published maps the plotting of the upper river is completely wrong. No stream of any size can enter the Guayabero from the south above Puerto Crevaux. I observed a high range of mountains, an outspur from the Cordillera Oriental, from both the north and south. The source of the Guayabero must be about east of Barraya, since in years gone by there was a trail between Uribe and Barraya. It is probable that the headwaters of the Guayabero, Balsillas, Venado, and Guaraco, flowing respectively to the northeast, southeast, northwest, and southwest, are all close together under conditions such as exist on the Páramo de Sumapaz where the Ariari and Guejar flow northeast and southeast respectively and the Sumapaz and Cabrera northwest and southwest.

Between Puerto Crevaux and the first *salto* downstream, where the river cuts through the Cordillera de Macarena, several small streams enter the Guayabero from the south side. One of these, which joins the main stream a few miles below Piedra Julio, the end of our survey, is said to be the Río Caraguaja. One of our engineers, Curt Zeiz, made an exploration of the upper part of the Río Pato and of Piedra Julio. He was drowned, however, or murdered by his native helpers, in November, 1923, after reaching the Río Guayabero. His notes were recovered, and his route mapped from them shows that the country he traversed was extremely rugged with streams flowing in deep canyons. I have refrained from connecting the creeks traversed by his route, but I believe that they belong to the Río Caraguaja drainage. It must be stated, however, that here and everywhere throughout this region the names of rivers repeat themselves and that another Caraguaja is said to exist which unites somewhere with the Río Pato of the Caquetá system.

The first large river entering the Río Guayabero from the north is the Papamene, which we explored from its mouth to the point where it is crossed by the Columbia-Uribe trail, although the lower part was not actually surveyed. It has a larger drainage area and carries a much greater volume of water than the Guayabero above their junction. It is 135 feet wide where the trail crosses it and can only be forded on muleback during the end of the dry season in February or March. The principal channel of the Río Guayabero at Puerto Crevaux is 270 feet wide, and I could cross it but once on muleback and then only with the help of a native leading the animal by a long rope.

Below Puerto Crevaux, on the left bank, the quebradas Tigre and Reserva and the Río Duda join the Guayabero. Zeiz and I explored the latter all the way from Uribe to its mouth. From La Julia downstream the exploration was made in a *canoa;* but, by checking the velocity of the *canoa* a number of times along measured distances and by repeating the survey upstream, I believe we obtained a fairly accurate survey. For some distance upstream from its mouth the Río Duda has the appearance of a large lake with almost no current, while the Río Guayabero is still a great mountain torrent with much vertical erosion.

METHODS OF SURVEY

For the surveys from which the accompanying map has been compiled the Brunton compass was chiefly used. The Zeiss stereotelemeter was used occasionally, and it would be an ideal instrument for both land and river reconnaissance work if it did not get out of adjustment so easily. In fact, I have found it impossible in these regions to keep any delicate instrument in adjustment for any length of time. It is impossible to make the native boatmen or carriers understand that even a slight knock makes the instrument useless. Heights along the route of the survey are from aneroid readings checked by boiling-point thermometers with a von Dankelmann hypsometer made by Fuess of Berlin. The thermometers used had all been examined and certified by the Physikalische Technische Reichsanstalt of Berlin. I cannot explain the rather large differences between the elevations determined by Dr. Rice and by my expeditions at Cáqueza, Villavicencio, and San Martín, as they were doubtless made in the same places, at or near the plazas in these villages. The Oficina de Longitudes of the Colombia government gives altitudes between Dr. Rice's and mine as follows, calculated in feet:

	Oficina de Longitudes	Rice	Martin
Bogotá	8659	8674	8659
Caqueza	5582	6212	5008
Villavicencio	1588	1832	1499
San Martín	....	1682	1409

During our explorations astronomical observations for latitude and longitude were made at several points; but most of the records were lost in crossing rivers, and only the latitude of El Duda, near the village of Uribe (3° 17′ N.), and the magnetic declination at the point (2° 25′ C.) can be accepted as correct. Observations for longitude by the Oficina de Longitudes place the longitude of Villavicencio 49′ 23.55″ east of the position given by Dr. Rice. On the map of Colombia on the scale of 1:1,000,000 published in 1920 by the Colombia government on the basis of astronomical positions established by the Oficina de Longitudes, Villavicencio has been placed at the position determined by the Oficina de Longitudes; but San José, Calamar, and other points farther south and southwest have been left as determined by Dr. Rice, because the Oficina de Longitudes has no determination for these points. My own work leads me to conclude that San José and Calamar should be shifted about the same distance west as Villavicencio.[10]

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[10] In compiling the accompanying map Mr. Martin's surveys have been adjusted to astronomical positions determined by the Oficina de Longitudes as far as these were available. In order to give a picture of the region of Mr. Martin's surveys the courses of the right-bank tributaries of the Magdalena taken from various official Colombian maps as indicated in the list of sources given on the map have been adjusted to Mr. Martin's surveys at their headwaters and drawn in broken lines. Similarly east of the region of Mr. Martin's surveys the courses of the main streams have been plotted from Dr. Rice's surveys and from official Colombian maps, Dr. Rice's positions having been shifted westward as suggested by Mr. Martin. Approximate contours have also been sketched in broken lines outside the areas covered by Mr. Martin's surveys.—Edit. Note.

EROSION PAVEMENT

Charles F. Shaw

University of California

EROSION pavement" is a surface covering of stone, gravel, or coarse soil particles accumulated as the residue left after sheet or rill erosion has removed the finer soil. It is in evidence whenever the soil mass contains fragments or cemented aggregates too large to be moved by the flowing sheet of water. These coarse particles check the flow of run-off of the surface water and thus reduce its powers of erosion. If, however, the surface flow is concentrated or increased to the point where the coarse particles can be transported, they act as additional cutting tools; erosive action increases; and deep, steep-sided gullies are excavated.

This action is clearly seen in Figures 1 and 2, showing erosion near Santa Monica, Cal. The soil here is Pleasanton loam,[1] containing a moderate quantity of gravel in the surface or A horizon but not enough to be classed as a gravelly loam. The subsoils, or B horizons, contain considerable gravel and are enriched with sufficient illuviated clay to be classed as clay loams. Cuts made by street grading afforded major drainage ways, and the burning of grass and weeds exposed the surface to washing by the winter rains.

Sheet erosion completely denuded the burned portion of its surface soil, but the sparse cover of unburned grass in the central part protected the surface and so reduced the erosion that three or four inches of surface soil still remain in place. The gravel that was present in the soil accumulated on the exposed subsoil to form an almost complete cover (Fig. 2) which served to protect the soil mass from further stripping. Where the volume of water was sufficient to move the gravels, however, deep gullies were cut, the gravels serving as efficient cutting tools.

The accumulation of gravel or stone as a protective covering is also shown in Figure 3, a cornfield on Dekalb stony loam in Clearfield County, Pennsylvania.[2] This is a primary or residual soil formed through the weathering of sandy shales, with many angular rock fragments throughout the soil mass. Sheet erosion has removed the fine material from a sufficient depth to give an "erosion pavement"

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[1] J. W. Nelson and Others: Soil Survey of the Los Angeles Area, California, *U. S. Dept. of Agric., Field Operations of the Bur. of Soils, 1916* [*18th Rept.*], pp. 2347–2420.

[2] C. F. Shaw, W. C. Byers, and W. G. Ross: Reconnoissance Soil Survey of South-Central Pennsylvania, *U. S. Dept. of Agric., Field Operations of the Bur. of Soils, 1910* [*12th Rept.*], pp. 193–265.

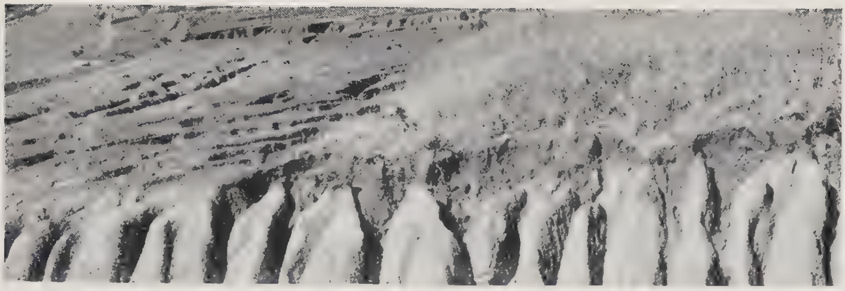

FIG. 1

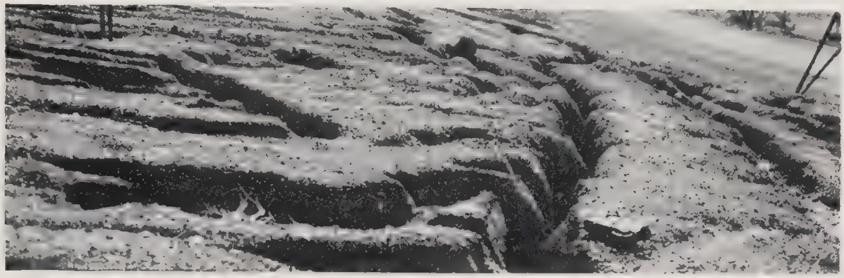

FIG. 2

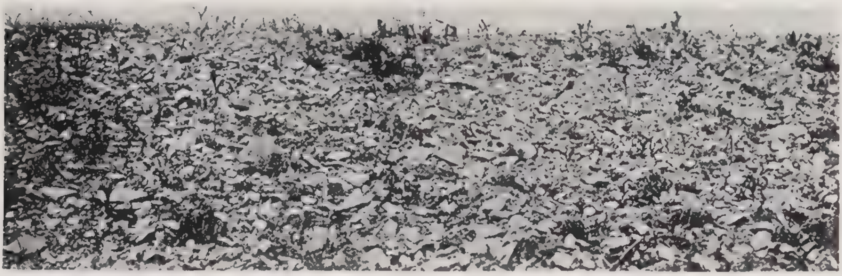

FIG. 3

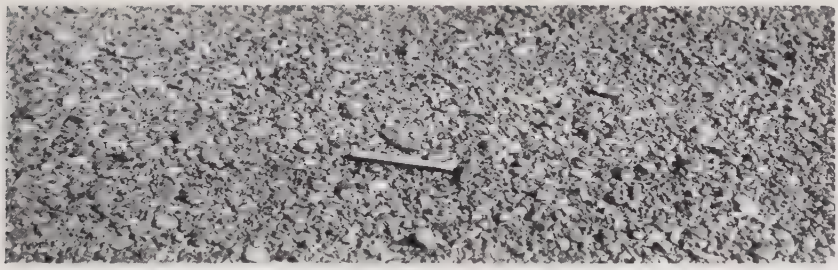

FIG. 4

FIGS. 1 and 2—Erosion near Santa Monica, Cal. The surface soil has been removed, and where the flow of water was concentrated deep cuts have been formed. The subsoils are protected by accumulation of gravels as an erosion pavement.

FIG. 3—An erosion pavement of accumulated stone fragments protects the surface and reduces further erosion. Dekalb stony loam. Clearfield County, Penn.

FIG. 4—Desert pavement on Palo Verde Mesa, Cal. The gravel content of the original material acts as a protective surface cover.

that completely covers the surface. The stone fragments are so large that they cannot be transported by the run-off water, and no gullies were formed. All erosion occurred in rills or small crooked channels.

The "erosion pavement" formed by sheet erosion is quite analogous to the "desert pavement" formed by wind erosion in the arid regions. Figure 4 shows a complete desert pavement on the Palo Verde Mesa, formed by wind erosion of a sandy loam which contained considerable gravel but not sufficient to be classed as a gravelly sand loam. The fine material was blown away, the gravels accumulating until they covered the surface and markedly reduced or prevented further erosion. The low content of gravel in the original material indicates that a depth of at least two feet had been removed to accumulate the pavement shown in Figure 4.

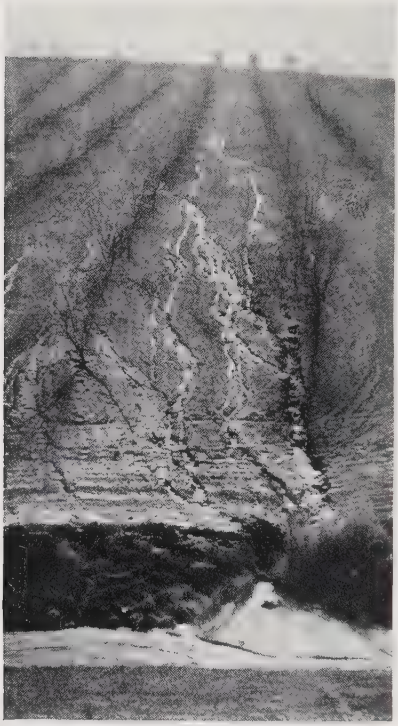

FIG. 5—Erosion in almond orchard, San Luis Obispo County, California. Ten to thirty per cent of the area was denuded of its surface soil, stripped off down to the "plowsole." The soil was a clay loam with no coarse particles, and no erosion pavement was formed. Subsequent cultivation obliterated evidence of this erosion.

Erosion pavements can be formed only when the original soil contained the necessary coarse fragments. Sheet erosion is always inconspicuous; and, if coarse materials are not available to form this type of evidence, its effects may go wholly unnoticed. This is true even in cases as extreme as that shown in Figure 5, in San Luis Obispo County, California. This hillside almond orchard is on a fine-textured clay loam with a clay subsoil. The continuous cultivation, often done soon after a rain when the soil was quite moist, had developed a definite "plowsole," or layer of compact puddled soil, that markedly retarded the downward movement of water. A heavy rain, characteristic of the occasional precipitation of that rather dry region, gave a run-off that cut numerous small erosion channels from one inch to a foot or more in width, stripping away the surface soil down to the "plowsole." In the portion of the orchard shown in Figure 5 the combined width of these channels often exceeded twenty-five per cent of the width between tree rows, and throughout the orchard it averaged well over ten per cent. From ten to twenty per cent of the surface soil was washed away by this one storm; yet, after the first cultivation a few days later, no evidence of this loss could be seen.

Where the soil mass contains some stone, gravel, or coarse sand such evidence of erosion is not lacking, as these coarse fragments accumulate on the surface after any rain. This accumulation is caused by sheet or rill erosion, which washes the finer material *off* the surface, and by the percolating waters which may wash some fine material *into* the soil. This accumulation of coarse material to form a protective covering over the soil is designated an "erosion pavement." It is definite evidence of the activity of sheet erosion in the denudation of that surface.

THE GEOGRAPHICAL MUSEUM

Benjamin Semenov-Tian-Shansky

State University and Central Geographical Museum, Leningrad

THE Central Geographical Museum in Leningrad has this year (1929) celebrated its tenth anniversary. It may therefore be a not inopportune moment to discuss some general principles regarding the construction of geographical museums, using in illustration the experience of myself and my collaborators in the Leningrad Museum.

At the time of the great German geographers, Alexander von Humboldt (1769–1859) and Karl Ritter (1779–1859), the ideas of geographical science and its methods of investigation were fairly clear, if somewhat different from those of today. In this same period, exactly one hundred years ago, the great Russian writer Gogol first emphasized the need of a close connection between geography and graphic art. One might have expected the geographical museum to follow. That it did not is to be ascribed to various causes. In the first place, after the death of Humboldt and Ritter there began a great specialization in the natural sciences which constitute the foundation of geography, and little by little the opportunity for geographical synthesis was lost. Indeed, by 1881 among the assembled geographers of the International Geographical Congress at Venice we see much confusion as to objects and methods of geography.

In the second place, in the time of Humboldt and Ritter cartography was little developed. Even the greatest geographical works often were not provided with maps. Photography was in its early stage, and graphic representations of the geographical landscape were still very conventional and unrealistic while reproduction in color was entirely unknown.

Furthermore, the rapidly growing museums of the various branches of natural history and the humanistic sciences devoted their attention exclusively to the exhibition of material articles in accordance with their natural classification, paying no attention to geographical distribution or explanatory maps or geographical pictures. They were needlessly one-sided and, confined to their narrow specialties, with the exception of the art and zoölogical museums, they were visited almost exclusively by the specialist. Thus the geographical aspects of museum exhibition, from being neglected, became discredited; and for a long time the idea of a geographical museum entirely lacked support.

THE IDEA OF A STRICTLY GEOGRAPHICAL MUSEUM

Towards the end of last century the great countries of the world began the practice of holding special exhibitions, some of them international, some local in character. Such were the World's Columbian Exposition at Chicago in 1893 celebrating the four hundredth anniversary of the landing of Columbus; the All-Russian exhibition in Nijni Novgorod in 1896; the International Exhibition in Paris in 1900. At these exhibitions there was some attempt to illustrate the geographical features of the countries concerned as well as their industrial character, for instance, the Russian section in the Chicago and Paris exhibitions and the Asiatic section in the Nijni Novgorod exhibition which were organized by the Russian geographer, P. P. Semenov-Tian-Shansky (1827–1914), pupil of Ritter. The exhibitions, however, suffered the disadvantage of being only temporary, while the inevitable advertising and competition detracted from quiet and objective exposition.

In 1901 V. J. Lamansky (1833–1914), ethnographer and historian, in planning the establishment of the ethnographical section of the Russian Museum, first called attention to the importance of establishing in Russia a permanent museum of the geography of man. But his idea, ardently supported though it was by P. P. Semenov-Tian-Shansky and Professor D. I. Mendeleev, was not appreciated, and this section of the Museum was organized on conventional lines. Not long before the Columbian Exposition at Chicago the idea of a permanent museum in a natural setting had been conceived in Sweden: this was Skansen, founded privately by A. Haselius in 1891.

At this time the geographers in several countries, roused by the disrepute into which geography seemed to have fallen, revived the question of its nature and scope, and a solid theoretical base for the subject and thus for the establishment of the geographical museum began to be laid. In particular I may cite the work of W. M. Davis (1906) in the United States, H. R. Mill (1894) in England, Alfred Hettner (1905) and Ewald Banse (1912) in Germany, Paul Vidal de la Blache and Emmanuel de Martonne (1909) in France, E. Chijov (1896), A. Yazilov (1905), L. Berg (1915), J. Lukashevich (1917), and myself (1915) in Russia. The "geographical landscape" idea of Hettner proved a fruitful concept for the geographical museum. I myself have applied my hexagonal scheme of geography which keeps the scope of the museum within strictly geographical limits. By this scheme the museum must confine itself to illustrating in order the distributional relations of (1) land and water, (2) land and air, (3) water and air, (4) land and plants, (5) water and plants, (6) air and plants, (7) land and animals, (8) water and animals, (9) air and animals, (10) plants and animals, (11) land and man, (12) water and man, (13) air and man, (14) plants and man, (15) animals and man.

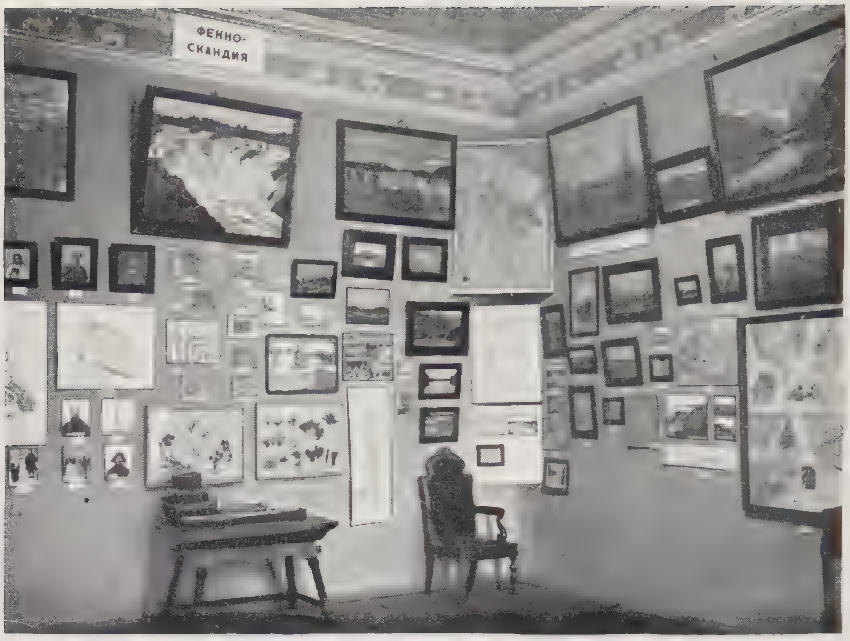

FIG. 1

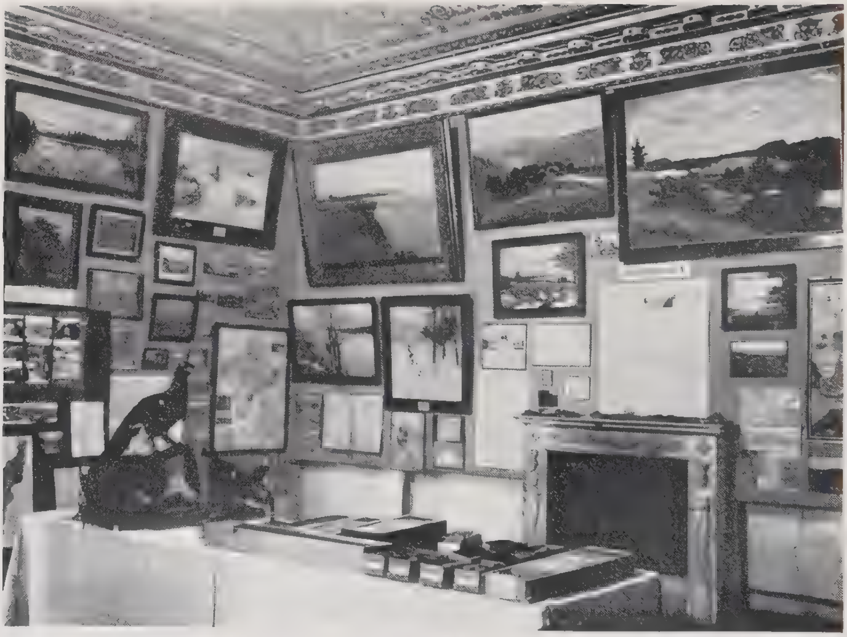

FIG. 2

FIG. 1—Central Geographical Museum in Leningrad. Section of the Land. A part of the hall of Fenno-Scandia.

FIG. 2—Central Geographical Museum in Leningrad. Section of the Land. A part of the hall of the Circumbaltic-Glaciated Region.

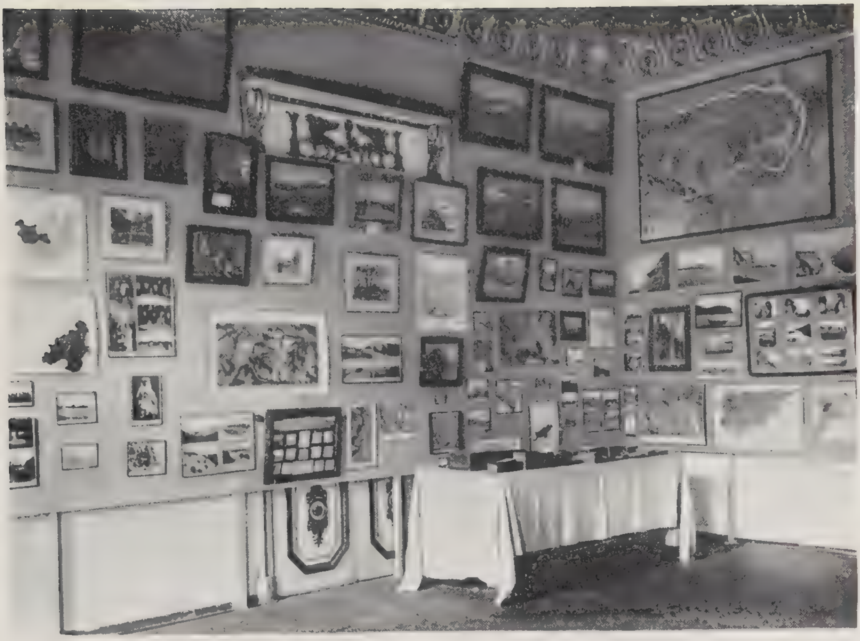

FIG. 3

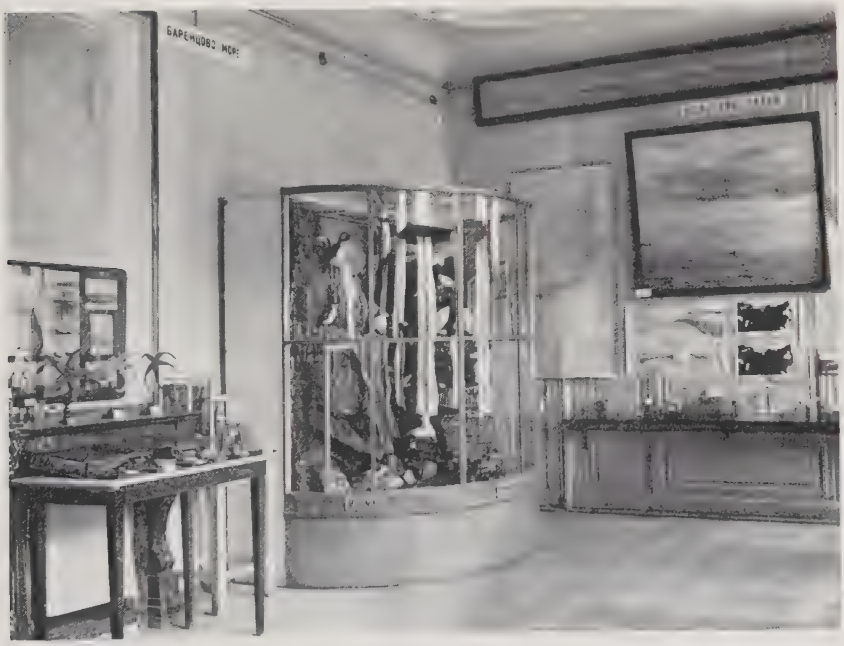

FIG. 4

FIG. 3—Central Geographical Museum in Leningrad. Section of the Land. A part of the hall of Forest-Steppe and Steppes.

FIG. 4—Central Geographical Museum in Leningrad. Section of the Sea and Fresh-Water Basins. A part of the hall of the Boreal Seas.

The Geographical Museum in Leningrad

In 1919 at the general museum conference held in Leningrad Professor A. Borsov proposed the establishment of strictly geographical museums at Moscow and Leningrad. He was desired to undertake the founding of the former, and at his suggestion the latter was entrusted to me. Borsov began to get collections together, but the transfer of the seat of government to Moscow and the overcrowded state of that city have not permitted housing of the museum up to the present time. By contrast there was no difficulty in obtaining accommodations in Leningrad because of the depopulation of the city and the abandonment of many large buildings. At first, with my colleagues, I thought of creating something like the Swedish Skansen, the "open air" museum, and the government accordingly assigned us the unoccupied palace of the late president of the Russian Geographical Society, Grand Duke Nicholas Mihailovich Romanov, situated some fifteen miles from Leningrad on the shores of the Gulf of Finland. Topographically the location was very favorable, and organization of the museum and geographical park was begun. But communication with the city was difficult, and the government would not assume the burden of further financial support. Orders were received to remove to the city, and there we settled in a small unheated and unlighted building, giving up the idea of the geographical park. Furthermore, funds for the maintenance of the museum were so curtailed that in 1923 we had available for scientific expenditure only $9.00 monthly and for house expenses only $5.00. The first years (1919–1922) coincided with the famine period, and it was difficult to work. One of our collaborators died of starvation; two others had typhoid fever, from which one died. Nevertheless the museum began to grow so fast that it has been obliged to move into a building three times the size. Funds have been increased, though still they can hardly be described as ample, amounting to about $8000 a year including the salaries of the staff, now numbering 12.

Contents of the Museum

At present the Central Geographical Museum has more than 3500 objects and over 3000 maps and books, most of them received as gifts from scientific societies and individuals. Maps, together with cartograms, diagrams, sections, etc.; pictures, panoramas, sketches, and photographs afford the best illustration of the geographical landscape and of man's activity therein; therefore they compose the main contents of the collections. Natural history and ethnographical objects are auxiliary, explaining details of the landscape shown by the maps and pictures; they occupy only a secondary place. Thus the geographical museum is distinguished from other museums by a picturesque and original air of its own. Much of the material, cartographical and pictorial, is new and unique. A good deal I have made myself. It is especially difficult to find true and artistic pictures in color. I tried two experiments in 1921, both of which proved successful. A photographer and an artist accompanied me to Karelia and made the desired sketches of this region. I have also made enlargements in colors of autochromes brought by geographers from other regions. The Central Geographical Museum has already exercised an influence on other museums of Leningrad—geological, mineralogical, ethnographical. They have lately started to provide themselves with pictures and maps in their own fields.

Of essential importance in the Geographical Museum is the systematic scientific catalogue. To each geographical region is devoted a separate section in which is provided a detailed explanation of the contents and meaning of each object exhibited. Two sections of the catalogue have already been made and will be printed as soon as possible, that is as soon as the Museum has the necessary funds.

The political and administrative boundaries of the countries of the world are in large part distinctly artificial and more or less temporary, often not coinciding at all with the natural features. For instance, the naturally swampy region of Polesie, entirely populated by White Russians, is divided by the political boundary between the U. S. S. R. and Poland. But, as our Geographical Museum is concerned only with the natural landscape in its relation to man's activity, not a single map in the Museum shows the political or administrative boundaries but only the physiographic regions, according to the terminology of W. M. Davis, inclosed in permanent physical boundaries. It is mainly the territory of the U. S. S. R. that is represented; but for comparative purposes we must sometimes cross the borders, and it is the intention of the Museum to extend this comparative study to America. In this respect, however, I must regretfully remark that material is still very scarce. The physical regions according to which the contents of the Museum are disposed are approximately those shown in the map of "The Natural Landscape" in my article "Russia: Territory and Population," published in the October, 1928, number of the *Geographical Review* (p. 619).

So far the Museum is divided into two main sections: (1) the land and (2) the sea and freshwater basins. In the latter, in addition to the exhibition of the geographical characteristics of the seas adjacent to Russian territory, general oceanography is presented and methods of oceanographical research with the exhibition of instruments. With removal of the Museum to more ample quarters it will be possible to expand the auxiliary sections. These are: (1) theory of geography (drawings and schemes); (2) history and methodology of regional divisions (maps and tables); (3) history and methodology of the geographical map (maps, lithographic stones, machinery, etc.); (4) conservation (pictures, photographs, maps, natural history objects); (5) technique and method of scientific expeditions (tents, packs, equipment, instruments, outfit, diary, route maps, portraits of famous travelers); (6) methodology of geographical research of small regions (instruments, models, maps, graphs, schemes, tables, samples of collections, etc., and portraits of famous geographers), this section being organized by the geographical students; (7) scientific motion pictures with films of various expeditions, rotatory panoramas of the artist, Dr. Piasezky, and the hall for lectures; (8) library and map collection.

The Geographical Museum in the Future

Recently geographical museums have begun to appear in other countries also; I am not however acquainted with the principles on which they are based. Further information about museums of this kind in geographical papers is to be desired.[1] The ideal of the future undoubtedly is a general geographical museum of the whole earth created by international coöperation of geographers. It should be established in some appropriate natural setting. It would be good to devote to it an entire island of varied relief laid out on a grand scale as a geographical park in which separate buildings, encircled by characteristic natural vegetational formations, would house the permanent exhibitions of the entire physical (not political) divisions of the globe. The prototype of such a park, it may be said, already exists in the botanical garden of subtropical flora near Batum, which was laid out according to the plans of the geographer, the late Professor Krasnov. He had an idea, similar to that of Skansen, of settling representatives of the various tribes in their natural surroundings, but financial difficulties prevented him from putting his plans into effect. In our world museum representatives of the fauna and of the human occupants of the regions should also be installed. Where climatic conditions are naturally too different, artificial heating or refrigeration would be resorted to.

Such a museum undoubtedly would be a place of pilgrimage for educated men from all the corners of the earth; and it would be the best school of geography on our planet. How can the ideal be realized? It is hard to say; but, if man has built great planetariums representing the whole of the skies of both hemispheres, we may at least hope that our ideal of a graphic representation of the whole earth in one place is not beyond the bounds of possibility.

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[1] Since this article was written accounts of the geographical museum in Leipzig have appeared in the *Geogr. Zeitschr.*, Vol. 35, 1929, pp. 40–44, and *Geogr. Anzeiger*, Vol. 30, 1929, pp. 42–46.

THE GEOGRAPHIC DISTRIBUTION OF INVENTIVENESS

Mark Jefferson

THE first attempt to estimate the relative place of the countries of the world in civilization was made by the writer in 1911 on the data they themselves reported for schooling, commerce, railways, and mails.[1] It found the nations falling into four culture groups which were distinctly regional and were called Teutonic, Mediterranean, Levantine, and Oriental from regions of typical development. Canada, the United States, Australia, and New Zealand were Teutonic of culture, like their mother lands; just as Cuba and the Argentine in South America were Mediterranean, like Spain. Japan, adopting Occidental culture for more than half a century, had attained to a Mediterranean grade.

The civilization, or culture, of the study was frankly Western, European, and mechanical—the culture that actually dominates the earth. An Oriental culture has long existed which is incommensurable with this and not reducible to quantitative expression. Of the three greatest peoples of the East, Japan has frankly adopted Occidental ways, China would like to adopt them if she knew how, and India must acquire them before she can take much part in controlling her own destinies.

In Europe contiguity means similarity of culture. The Netherlands and Belgium both rank high, Bulgaria and Rumania both low. Austria-Hungary, grading 5 between Switzerland 10 and Rumania 3, broke apart in the World War; and a preliminary study for 1925 reveals Switzerland 10, Austria 6, Hungary 3+, and Rumania 2−(Fig. 1). The new study uses five new criteria, of which inventiveness proved the most interesting as soon as the significance of patent reports was perceived.

INVENTIVENESS

In civilized countries nowadays patents afford a record of inventions, but these patents are very modern things. Man has been inventing things since the dawn of humanity. Civilization in our western sense may be said to be an integration of human inventions. But until recently inventions had an anonymous character as if mankind, not men, invented them. Only admitted and confessed legends made any pretense of naming the inventor of any important tool.

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[1] Mark Jefferson: The Culture of the Nations, *Bull. Amer. Geogr. Soc.*, Vol. 43, 1911, pp. 241–265.

Who devised the plow, the ax, the chisel, the hammer, the saw, the nail, the screw, the earthen pot, the twisted thread? There is no likelihood that any one person acquired power or wealth among his fellow men by inventing any of these things.

The World's Patents

Inventions began to acquire real importance to their creators when steam was substituted for muscle as motive power, with enormous resultant increase of wealth for the individuals who controlled the new processes. It is at this point of man's history that patents for inventions began to be issued and recorded. Before 1870 less than 400,000 patents had been granted in all the world. Now the number of patents has become 5,000,000. They provide an admirable means of comparing the inventiveness of different nations.

But patents are not inventions, nor are their numbers equivalent. Very likely our five million patents cover much less than a million inventions. Whoever invents something that he is persuaded will sell widely, if he can get the means to manufacture it, will take out patents on it in as many different lands as he believes offer him a possible market. So some American patent issues are made to American inventors and some to foreign inventors who have patented their ideas at home and seek patents in the United States also, among a number of additional countries. Each country issues patents both to its own nationals and to residents of other lands. Patents are matter of many international agreements and conventions. Procedure is usually the same for any applicant. It is merely provided that if he is a foreigner he must have somebody in the land where the patent is issued to represent him. The patents to foreigners are surprisingly numerous. Most countries grant more patents to foreigners than to their own people. The United States, the Soviet Republics, and Germany are the only countries that in 1925 issued more than two-thirds of their patents to the home inventors. There are but four others—Japan, France, Denmark, and the United Kingdom—to issue more than half their patents to their own people.

Records have been assembled for 1925 of 180,000 patents issued in thirty-two countries. Twenty-five of these issued more than half their patents to folks abroad. For instance, Canada granted 7891 patents to "residents of the United States" and 1292 to residents of Canada. Officials point out that "residents of the United States" are not necessarily Americans. They might be Canadian, British, or German. That is true: some of them are, no doubt, but it is also true that most of them are American firms or American individuals with an invention that they wish to market in Canada as well as in the United States, where they have patents already. Of course, the

7891 patents referred to are not an indication of Canadian inventiveness. They merely show that Americans regard Canada as a desirable market. Canada grants 85 per cent of her patents to nonresidents. Belgium grants 74 per cent of hers abroad. That the United States, of all reporting countries, issues the smallest proportion of her patents abroad—eleven per cent—is probably due to our remoteness from other continents and lack of intimate international relations. The country that comes nearest to the United States in this respect is Soviet Russia, very low in inventiveness and not just now a good place for foreigners to exploit patents, because of her unsocial behavior among the nations of the world.

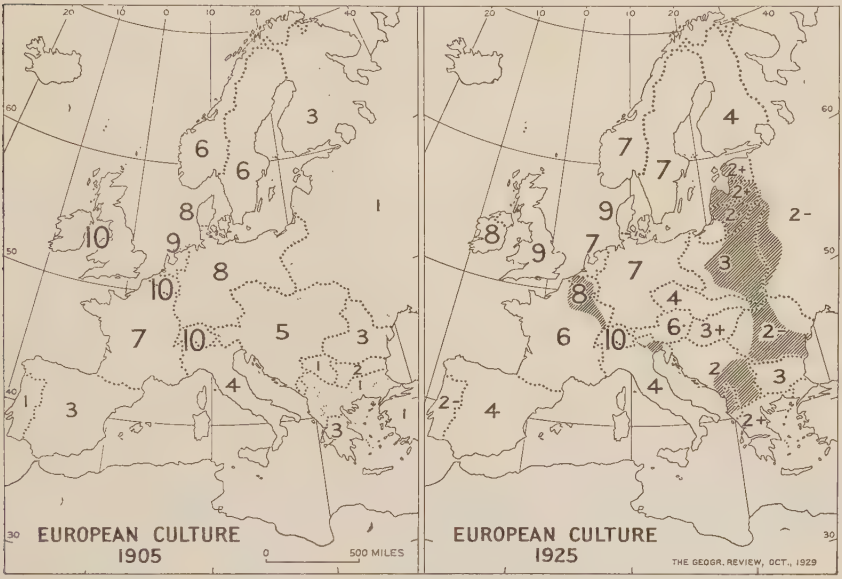

FIG. 1—Comparative culture of the European nations in 1905 and 1925. The indices for 1905 are based on statistics for schools, commerce, railways, and mails: the indices for 1925 on schools, commerce, railway mileage, railway freight, mails, automobiles, telephones, cities, patents.

INVENTION ACCOMPANIES TEUTONIC CULTURE

The achievements of the age of machines have been especially concentrated in western Europe and eastern North America, the regions of the two great railwebs. There "every field, every factory, every forest, every mine, every village, and every home in all this region is within easy reach of railway transportation, the agency that for the century past has done more than any other single one of man's inventions to transform human life, especially in the way of pushing backward people forward and lifting submerged classes. The old-fashioned peasant, clinging closely to the ways of his fathers, and accepting a status of inferiority, has disappeared here before the whistle of the locomotive and the rustle of the newspaper."[2] Most of the recorded patents—83 per cent of those of 1925—have been granted in the United States and Canada and the belt across Europe from Ireland to Italy—Britain, the Netherlands, Belgium, France, Germany, Switzerland, Austria, Hungary, and Italy, on the two opposing sides of the northern North Atlantic.

However, these figures cannot be used to judge national inventiveness. To say nothing of calling Belgium five times as inventive as the Netherlands, which it cannot possibly be, the basal assumption that a patent means as much in one country as in another is quite inadmissible. The best established tenet in the geographic distribution of human culture is that neighbor countries cannot greatly differ.[3] Culture is most contagious, and neighboring countries are fully exposed to each other's progress. Culture indices for England 10, the Netherlands 9, Belgium 10, Germany 8, and France 7 make sense. So at the other end of Europe do Greece 3, Turkey 1, Bulgaria 2, Rumania 3, and Russia 1.

TABLE I—NUMBERS OF PATENTS GRANTED IN 1925 IN LEADING COUNTRIES

COUNTRY	AT HOME		ABROAD	COUNTRY	AT HOME		ABROAD
	TOTAL	PER MILLION POPULATION			TOTAL	PER MILLION POPULATION	
United States	43,904	382	5,347	Germany	11,653	186	4,224
Canada	1,292	139	9,709	Switzerland	2,112	542	2,707
United Kingdom	8,556	191	8,610	Austria	1,605	239	1,675
Netherlands	368	49	1,280	Hungary	761	91	1,750
Belgium (1927)	2,211	283	6,641	Italy	6,162	152	7,800
France	10,740	264	7,260				

SOME DIFFERENCES BETWEEN PATENTS

A Dutch patent, like a British one, is a very serious affair, formal and costly. Belgian and French patents are inexpensive and are so easily obtained as almost to be had for the asking. In England you apply on a stamped blank costing £1, and on another stamped blank costing £3 you describe your invention so fully that a competent workman can construct it without further help. If a drawing is necessary for him, you must supply it and make it according to definite instructions. Then officials make a search of British records for the last 50 years, to make sure that you are not obviously repeating or invading another patent, and notify you that your application is accepted or refused—rather more being refused than accepted every year. Next, the description is printed in the official journal *Patents*. This gives interested parties a chance to oppose your patent if you are invading their rights. If all goes well, 18 months after your application the patent will be "sealed" to you on payment of another £1, and you may keep it in vigor for 16 years by advancing annual payments up to £16 for the 16th year. The first four years in England cost you $24, in Belgium $5. The whole British term of 16 years would cost you $636; the Belgian term of 10 years, $79. In Belgium there is no scrutiny or publication of your invention, and almost all applications are granted.

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[2] Mark Jefferson: The Civilizing Rails, *Econ. Geogr.*, Vol. 4, 1928, pp. 217–231; reference on p. 217.

[3] Jefferson, Culture of the Nations.

TABLE II—RANK OF COUNTRIES IN INVENTIVENESS IN 1925 AND NUMBER OF PATENTS PER MILLION POPULATION GRANTED ABROAD TO THEIR RESIDENTS

RANK	NUMBER	RANK	NUMBER	RANK	NUMBER	RANK	NUMBER
1 Switzerland	930	11 Belgium (1927)	180	25 Latvia	8	5 New Zealand	257
2 Sweden	299	15 Czechoslovakia	108	26 Bulgaria	7	12 United States	160
3 Austria	298	16 Hungary	68	27 Rumania	5	13 Australia	146
4 Germany	271	17 Italy	42	28 Poland	5	14 Canada	121
6 Denmark	236	18 Finland	40	30 Lithuania	4	20 South Africa	17
7 Netherlands	233	19 Spain	21	32 Portugal	2	21 Argentine	10
8 Norway	229	22 Yugoslavia	9	33 Turkey	0.9	29 Mexico	4
9 France	195	23 Greece	9	34 U. S. S. R.	0.6	31 Japan	3
10 United Kingdom	188	24 Estonia	9			35 India	0.5

In 1925 there were 84,000 applications for patents in Washington: less than 50,000 were granted. In London there were 33,000 applications, and 17,000 were granted. In Germany 65,000 applications, 14,500 granted; in Switzerland 3702 applications, 2707 granted. In Belgium 8504 patents were applied for and 8370 issued. In France the applications numbered 18,443, the patents issued 16,500. Certainly one patent is not the same thing as another.

INVENTORS' FOREIGN PATENTS

When inventors apply for patents in other lands than their own they stand side by side with other nationals, meeting identical conditions. Residents of the Netherlands, in 1925, obtained a total of 1737 patents in other lands than their own; residents of Belgium a total of 1559, doubtless in much the same countries. These numbers are strictly comparable. Of every million Dutchmen, 233 obtained patents in foreign countries; and 180 Belgians in every million Belgians.

The comparison of patents issued in other countries than their own, besides putting all inventors on the same footing as far as the cost and trouble of obtaining a patent are concerned, has the further

Table III—Numbers of Patents Granted in 1925†

Country Granting Patent	Country of Residence of Patentee																		
	Argentine	Australia	Austria	Belgium	Bulgaria	Canada	Chile	Cuba	Czechoslovakia	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	India	Italy	Japan
Australia	5	1,151	5	13	—	20	1	—	3	12	—	1	68	95	—	5	5	14	5
Austria	—	5	1,175	23	—	4	—	—	158	13	—	2	104	1,015	—	70	4	66	4
Belgium (1927)	6	29	103	2,211	—	20	—	2	76	92	—	2	1,669	1,717	2	37	3	151	9
Bulgaria	—	1	24	10	43	1	—	—	7	—	—	—	24	46	—	9	—	6	—
Canada	6	128	46	25	—	1,292	2	4	11	19	—	1	185	276	—	4	5	31	11
Chile	10	—	—	—	—	—	46	—	—	*3*	—	—	15	15	—	—	—	—	—
Czechoslovakia	—	6	187	37	—	—	—	—	769	22	—	3	249	927	—	36	—	46	—
Denmark	2	5	12	11	—	—	—	—	9	776	1	4	55	254	—	6	—	7	—
Estonia	—	1	7	1	—	—	—	—	—	3	59	4	17	69	—	8	—	—	2
Finland	—	2	9	1	—	—	—	—	4	19	—	163	25	114	—	3	—	12	—
France	—	73	127	347	—	43	—	—	198	90	—	16	10,740	1.585	4	43	—	420	40
Germany	4	25	247	124	3	20	4	—	204	61	1	8	763	11,653	—	75	1	174	11
Hungary	—	—	*185*	*30*	*10*	*2*	—	—	*80*	*10*	—	*10*	*136*	624	*30*	761	—	*108*	—
Italy	14	64	331	179	*10*	19	—	—	140	55	*1*	*5*	1,677	2,161	*10*	70	7	6,162	—
Japan	—	14	*8*	*10*	—	*13*	—	—	*4*	*12*	—	—	145	214	—	*6*	*11*	24	3.590
Netherlands	—	17	28	69	—	6	—	—	35	24	—	2	102	367	—	5	—	15	3
Newfoundland	—	1	2	—	—	4	—	—	—	—	—	—	—	2	—	—	—	—	2
New Zealand	1	98	—	1	—	4	—	—	—	3	—	—	7	7	—	—	1	4	1
Norway	—	10	21	18	—	7	—	—	22	56	—	9	86	278	—	8	—	16	2
Poland	—	—	113	34	—	—	—	—	109	13	—	—	175	668	—	33	—	31	3
Sweden	1	16	20	26	—	10	—	—	16	64	—	8	76	308	—	6	2	19	1
Switzerland	—	12	90	89	—	4	—	—	78	31	—	3	380	1,180	1	20	—	116	3
United Kingdom	18	165	163	208	—	146	—	4	155	109	1	20	1,022	2,271	1	43	33	225	42
U.S.S.R. (Russia)	—	1	36	9	1	—	—	—	21	5	1	37	30	889	—	9	—	18	2
United States	34	181	66	71	—	798	3	37	47	60	—	5	541	1,296	—	23	3	97	46
Yugoslavia	—	—	92	7	1	*5*	—	—	72	4	—	1	78	212	*1*	24	—	35	—

† Figures in italics are estimates.

advantage of extending our sources of information. From Spain, for instance, we have no report. Its patent office contents itself with affirming in the *Anuario Estadístico de España* that, in 1925, 3935 patents were granted, 3 denied, and 689 expired. However, other European countries enumerate the patents they have granted to residents of Spain, and from these totals the required number for Spain can be arrived at. There were 136 granted in France, 55 in the United Kingdom, 77 in Italy, 37 each in Belgium and the United States, 19 in Germany, and so on to a total of 400. Those are the facts for Spain, obtained without any Spanish report. From the reports of twenty-five patent offices we gather the facts we need for thirty-five different countries. Spain and Portugal, Latvia, Lithuania, Greece, and Turkey provide no available statistics; but we have their patent data from the countries where patents are granted to their nationals. So with Mexico and the Argentine Republic. These data, NUMBERS OF PATENTS GRANTED IN 1925 †

Country of Residence of Patentee																			Country Granting Patent
Mexico	Netherlands	Newfoundland	New Zealand	Latvia	Lithuania	Norway	Poland	Portugal	Rumania	South Africa	Spain	Sweden	Switzerland	Turkey	United Kingdom	United States	Soviets	Yugoslavia	
—	18	—	110	—	—	7	1	—	—	10	2	20	17	—	570	506	12	—	Australia
1	66	—	—	—	—	17	4	—	4	4	1	47	165	—	137	201	1	11	Austria
2	235	—	10	1	—	41	24	—	5	2	37	117	302	—	710	873	6	3	Belgium (1927)
—	7	—	—	—	—	—	—	—	3	—	1	—	9	1	7	8	—	—	Bulgaria
2	47	1	44	—	—	36	2	—	—	20	5	78	70	1	732	7,891	—	2	Canada
—	*5*	—	—	—	—	—	—	—	—	—	—	*6*	*4*	—	11	80	—	—	Chile
—	54	—	—	—	—	11	5	1	2	—	8	82	114	—	185	237	2	3	Czechoslovakia
—	37	—	2	2	—	40	2	—	—	1	1	62	22	—	74	89	1	—	Denmark
—	14	—	—	3	—	—	—	—	—	1	—	9	3	—	10	7	—	—	Estonia
1	17	—	—	—	—	19	1	—	—	—	—	110	8	—	14	19	—	—	Finland
—	181	—	14	—	—	58	24	4	14	—	136	150	635	3	1,361	1,503	8	3	France
5	119	—	4	6	2	52	29	1	4	4	19	177	605	2	523	881	13	6	Germany
—	*116*	—	*5*	—	—	*10*	*10*	—	*10*	—	*10*	*20*	*50*	—	*200*	*100*	—	*20*	Hungary
—	153	—	13	—	—	54	*9*	—	14	3	77	126	583	—	974	986	5	*27*	Italy
—	28	—	*6*	—	—	*5*	—	—	—	—	—	33	86	—	339	540	—	—	Japan
—	384	—	—	—	—	16	—	—	—	3	3	65	113	—	226	157	—	—	Netherlands
—	—	3	—	—	—	2	—	—	—	—	—	1	—	—	17	26	—	—	Newfoundland
—	5	—	200	—	—	1	—	—	—	1	—	3	2	—	93	60	—	—	New Zealand
—	47	—	1	—	—	480	—	—	—	3	3	167	58	—	122	187	—	—	Norway
—	61	—	—	—	—	8	510	—	4	—	1	37	27	—	80	110	1	2	Poland
4	51	—	4	—	—	66	3	—	—	7	4	687	64	—	157	303	2	—	Sweden
—	105	—	1	2	—	26	7	—	1	—	17	37	2,112	—	238	250	—	6	Switzerland
2	207	—	65	—	—	52	9	—	4	48	55	209	396	1	8,556	2,867	20	5	United Kingdom
—	57	—	—	3	1	4	1	—	1	—	11	46	3	—	72	82	6,044	—	U.S.S.R. (Russia)
39	76	—	56	—	—	53	3	—	1	24	19	156	221	1	1,344	43,904	3	2	United States
—	20	—	—	—	—	9	—	—	3	—	—	*10*	*20*	—	42	*50*	—	106	Yugoslavia

† Figures in italics are estimates.

shown in Table III, are entirely new. They have been collected from printed reports and direct communications from patent offices in many lands. Our consuls everywhere have been of the greatest assistance in collecting them. The figures are for 1925 except those for Belgium.[4] Russian data were supplied by the Amtorg Trading Corporation in New York in the form of numbers of patents granted to the residents of various lands from October, 1924, to October, 1927. A third of each of these values has been assumed to be the approximate value for 1925. Sometimes it was difficult to ascertain the numbers of patents granted by countries, as that annotation is made only on the applications. This was the case for Denmark; but, the applications numbering 2733 and the patents granted 1465,[5] the number of applications from each country has been multiplied by .54, the ratio between these two numbers. Similar treatment had to be given the New Zealand figures.

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[4] By an error of a clerk employed to extract the Belgian data from the patent office records—as Belgium neither publishes nor compiles the issues by country of residence—the record for that country is all for 1927.

[5] Letter of Mr. Chas. Hude, patent attorney of Copenhagen, July 11, 1927.

How many patents, however, were granted to the French or the English in Spain or Portugal, or any other of the countries for which no statistics were obtainable? Estimates could often be made. It has been possible to check these estimates in some cases, and they have been shown to be reasonably good—as the instance of belated data from Austria and Bulgaria shows.

Extra-European Countries

The United States is at a disadvantage by reason of its lack of reports from neighboring countries. It has not been possible to obtain reports from twelve of the fifteen American countries to whose residents our patent office grants patents. We issued 130 patents to these twelve countries in 1925. Remembering our great excess of population over our neighbors, which was no doubt the reason why Canadians obtained but 798 patents at Washington while Americans obtained 7891 at Ottawa, it is certain that many hundred, perhaps a thousand or more patents were taken out by Americans or American firms in Mexico, Cuba, and other Latin American countries which report "data not available" when applied to from this distance. All told, twenty-one of the fifty-one countries to which we issue patents are not represented in our reports.

In this respect New Zealand fares better. She grants patents to residents of Australia, Belgium, Canada, Denmark, France, Germany, the Netherlands, Italy, Japan, Norway, Sweden, Switzerland, the United Kingdom, and the United States, all of which have reported. She also grants patents to the Argentine Republic and India, from which no reports are at hand—two countries not reporting out of a total of sixteen. As the two countries get only one patent apiece in New Zealand, the missing numbers are not likely to be of importance. Even in the case of the United States the missing numbers would hardly raise the index of invention per million citizens more than to 170 or 180 (for whites only, say 190 or 200).

Perhaps the New Zealanders have more of one quality called for by high indices than have the people of the United States. A man must have, I suppose, a certain extranational-mindedness to be led to take out a patent in a foreign country. We have so vast a country with so great and rich a market, such freedom from tariff barriers throughout its extent, freedom from language barriers, and from national barriers for thousands of miles that we have not learned to look abroad for business. Our participation in international trade is very small, $78 per capita in 1925, while 26 European countries averaged over $90. We had a low commercial index in 1905 and again in 1925. Norway, Sweden, Denmark, Austria, Switzerland, the Netherlands, France, Belgium, and the United Kingdom all excel us in this respect. We do a huge amount of buying and selling within our own country, probably more than the people of any other land, but not much commerce across frontiers. Our tariffs have never encouraged trading abroad. We have a minimum of contact with foreign peoples; and, since the passing of the clipper ships, we have not had much opportunity for such contact, that is away from the great port cities which are not so much America as the anteroom to America.

We are a people of one language as few European peoples are. The great masses of our native-born citizens are unfamiliar even with the sound of other tongues than their own. Probably we have a smaller proportion of persons who know another language than the mother tongue, a very large part of those who do being the foreign-born, a generation that is passing away. Even in the gross we do not visit other countries as much as Europeans do. In Switzerland, for instance, travelers from America are still fewer in total number than travelers from Germany and, in proportion to our numbers, of course fewer still. In Switzerland the natives use three important languages in all the affairs of life; and a considerable class of business and educated men are familiar with still other languages, such as English. All of these considerations make intercourse with foreigners easy and natural to nations like the Swiss and difficult for us. This creates in us a certain aloofness and disinclination to international undertakings like a World Court or a League of Nations. It is not that we are wanting in generosity or sympathy with others, for these sentiments are highly developed in the United States and the national prosperity and wealth permits their exercise: it is that we lack habitual intercourse with foreign nations and acquaintance with foreign ways.

Certainly these considerations account in part for Switzerland's enormous lead in patent grants. So, too, of Austria's long association with Hungarians, Czechs, Ruthenians, and Croats. So, too, of the Scandinavians. Two millions, three millions, and six millions of people in three neighboring nations understand each other fairly well, if they do not like each other much in spite of the associations of a thousand years of contact, and do important business every day with vastly more numerous peoples around them, with whom their existence has come to be knit. Danes depend on the English to take their butter and bacon, Swedes need the London papers to consume their wood pulp. And the Dutch and Belgians alike are groups of but seven millions each doing business with forty-five million British on the north, forty million French on the west, and sixty million Germans on the east. With these people international-mindedness is a part of business and life; business and life with us keep our thoughts at home.

Internal Variation of Inventiveness

The larger countries are far from homogenous in their different sections, as an examination of home patents issued to different parts of some countries shows. This is in a measure due to the fictitious importance of the capital city, where the patent office is usually located. Paris, Berlin, London, and Washington receive much more than their share of the patents issued to home residents, merely because inventors take residence there while obtaining their patents. But Westphalia and the Ruhr take out more patents than Pomerania and East Prussia, both agricultural. In Britain, where 188 in every million get patents "abroad," 191 in a million take out a patent at home, which are very similar values. By districts there were 221 to the million in England, 88 to the million in Scotland, 51 in Wales, 51 in Northern Ireland, and 17 in the Irish Free State—the English figure being increased and the others lowered by the flocking of inventors to London as the seat of the patent office. The persistence of the Irish Free State as a part of the United Kingdom comes of the fact that their own patent office first opened for business in 1927.

In the United States there were 160 patents per million persons obtained abroad, and 382 patents per million issued to residents of the country. The home patents are reported by states. We have no data for patents granted abroad to residents of the different states, but we may use the home patents if we bear in mind that they are more than twice as large numbers as "patents abroad" (382 to 160). Connecticut leads the country, with 920 home patents per million white persons; then come California and New Jersey with 760 and 740; the southern states run down to 100 and 150. Connecticut's figure cannot be due to the crowding of inventors to take residence near the patent office. That would take them away from Connecticut to Washington.

Japanese Inventiveness

Japan seems to me much more significant in invention than her low place in the list (31st) implies. Americans, Canadians, Australians, and New Zealanders are of course Europeans by culture and blood. Their inventiveness is a leaven of European inheritance working in a new-world environment. But Japan is a purely Oriental people which has known of our Western mechanical culture for less than a century and yet gone far in mastering it. How astonishing that it should be a scientist of this race that the Rockefeller Institute for Medical Research sent to Guayaquil when appealed to for help in cleaning up that last stronghold of endemic yellow fever. It is not merely by its army and navy that Japan has commanded the respect of the world. She has made wonderful beginnings of education and industry and has an imposing merchant shipping on the ocean. Her culture was rated in 1911 as Mediterranean, i.e. below the Teutonic countries, but her rise to that place was regarded as phenomenal, unparalleled by any Western nation. Mr. Orchard thinks she should not be called the England of the Orient because her industry is so far below the English development.[6] Not an England *in* the Orient, no doubt, but quite English *for* the Orient. If it is possible to get from the phrase a notion that Japanese industry is comparable to that of England, the words are misleading. Yet Japan is more in the lead in Asiatic industry than England is in that of Europe.

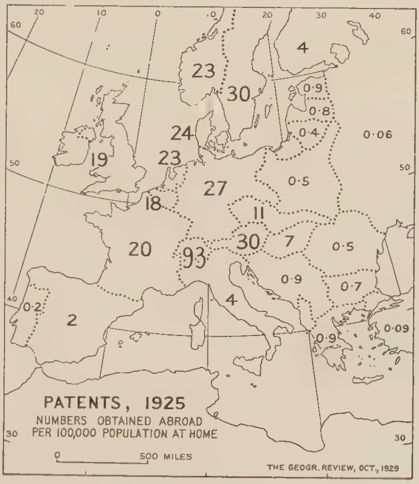

FIG. 2—The number of patents obtained abroad in 1925 by residents of European countries per hundred thousand population.

The most singular feature of Japan's progress is that it has been accomplished by her intellectuals out of patriotism. Rulers and aristocrats have resolved to scrap their past in order to give their country a place in the world worthy of their devotion to it. The common people have not scrapped their past and have little understanding of what is happening to the national institutions. An obedience to their rulers that the West knows not is their contribution to the national accomplishments. There have been no Watts or Stephensons from Japan's lower classes to raise Japan in industry. Only a very limited class in the nation has really wrought out the wonderful transformation it has undergone. When we divide the 187 patents granted in other countries to residents of Japan by the whole population of the country we are diluting the national inventiveness by an unfair mass of unproductives. The 160 patents per million of the United States have a dilution in the negroes in our population. If we eliminate them the number might be 180 or even 190, and the Japanese inventions of three per million would be manifold greater if we could eliminate from the divisor all the Japanese who have not caught the contagion of Western culture. It would be most interesting to know the social status of the 46 residents of Japan to whom the United States granted patents, the 42 granted patents in England, and the 40 in France.

Very striking on the map that sets out the indices of inventiveness of the European peoples is the sharpness with which there rise above the Mediterranean countries the nations of Teutonic culture—Austria, France, Germany, the Netherlands, Belgium, Britain, Sweden, Norway, and Denmark, and, towering above all the others, Switzerland.

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[6] Compare J. E. Orchard: Can Japan Develop Industrially?, *Geogr. Rev.*, Vol. 19, 1929, pp. 177–200.

Swiss Leadership

What does it mean to say that Switzerland has 930 patents granted her inventors in foreign lands to every million Swiss people, while the other leading nations have but 200 to 300? Is it anything more than some trickery of figures? The facts are overwhelming. French reports —not Swiss ones—show us Switzerland, a nation of four million people, taking out 635 patents in Paris while the sixty million Germans got but 1585, only twice as many though they outnumber the Swiss fifteen to one. It is not war animosity that is keeping the Germans out of enemy patent offices. That was confidently expected; but the plainest result of this study is that sentiment is not concerned in the matter at all. Germany took out more patents in enemy France than in ally Austria. The table is full of illustrations. The forty-five million British got 1361 patents at Paris, but twice as many as the Swiss whom they outnumber eleven to one. In London the Italians got 225 patents, the Germans 2271, the French 1022, while Switzerland took 396—a number entirely out of proportion to her four million people. It is the same story in all countries: all patent offices report the Swiss as the foremost inventors.

The culture study for 1905, reasoning from schooling, commerce, development of railways, and use of the mails, gave Switzerland a slight lead among European nations, rating the order Switzerland, Belgium, United Kingdom, the Netherlands, and so on. A preliminary study of culture for 1925, with five other criteria added to those of 1905, puts Switzerland more strongly in the lead, the list ranking: Switzerland, United Kingdom, Denmark, Irish Free State, Belgium (Fig. 1).

A partial list of books published in different countries showed Switzerland to be far ahead of any other country in this sphere. In urbanization—the tendency to develop large cities that signalizes modern industrialism—Switzerland again occupies a foremost position. If by a great city we mean a city of a hundred thousand persons or more, she has four of them in a population of four million. Switzerland is highly industrialized. We have allowed the herdsman and the hotel keeper to loom too large in the Swiss picture. The Swiss import twelve dollars' worth of silk per capita, manufacture it, and export twenty-two dollars' worth per capita. Silk is America's greatest import; but even in this year 1929 it will not reach four dollars a head, and there are no exports of manufactured silk to count.

The Swiss themselves attribute much importance in the growth of their industries to the religious persecutions in neighboring countries in the sixteenth and seventeenth centuries—persecutions which drove thousands of intelligent men, of whom many were skilled workers, into Switzerland. The revocation of the Edict of Nantes alone in 1685 is credited with driving sixty thousand Huguenots from France into Switzerland. They founded the silk industry of Zurich and Bern. It was a Huguenot who founded the watch business at Geneva. The Huguenots introduced banking and wholesaling. Spanish persecution in the Low Countries and Swiss neutrality during the Thirty Years' War added to the human resources of Switzerland. In other countries originality manifests itself in a chosen few of their people. Switzerland naturally has her own share of these together with many thousands of original, enterprising spirits from neighboring countries. It is no wonder Swiss inventiveness runs high.

The enriching of Switzerland by this addition of choice spirits was enhanced by the largeness of the French population from which they were culled and the smallness of that of Switzerland to which they were added. The persecutors of the Huguenots were in effect applying an intelligence test to their people and expelling (or slaughtering) the most promising. How curious that the American enforcement of immigration quotas had the result of cutting down a Swiss immigration of 8000 in 1923 to 4140 in 1924, effectively counting them undesirables as did the men who drove the Huguenots out of France!

How interesting it would be to accept the lesson of history and admit freely the first half million foreigners, including Mexicans and other Americans, who attained an A grading in such intelligence tests as were used in the Army to sort out potential officers from the mass of recruits. We have been described as receiving the offscouring of Europe and doubtless we do get some. Why not frame our admissions to the United States on a basis of a clean police and health record and a high intelligence test?

THE CENTRAL PLATEAU OF FRANCE: A REVIEW*

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THERE are certain treatises which instantly take high rank in scientific literature, either because of the intrinsic value of their material contributions to knowledge, or because of the excellent manner in which the authors discuss their subjects. Baulig's "Plateau Central" will for both reasons take and keep a high place in the literature of geomorphology. The subject of discussion is of prime importance—one of the great natural regions of France notable for the variety and complexity of the problems it presents. Baulig's treatment adds extensively to our knowledge of the region's physical evolution and throws new light on many of its problems. And, best of all, his treatment is clear and analytical, obviously the work of one who at every step of the long and intricate discussion knows his subject in all its phases.

Divisions of the Central Plateau

The high table-land of Central France represents a complexly folded mass of ancient rocks, mostly crystallines, which were in different localities and at different times subjected to peneplanation with subsequent burial by sedimentary beds of later date. The peneplaned basement with its sedimentary cover was profoundly broken by a network of intersecting fractures, believed to be related to uplifts of the Pyrenees and Alps. The fault blocks were tilted, raised, or lowered, with renewed erosion of uplifted blocks and accumulation of débris on depressed areas. Where erosion stripped the sedimentary cover from back slopes of tilted blocks, the buried peneplanes were resurrected to form an important element of the present landscape. Vulcanism then contributed its part, while rivers continued their destructive work, the later history of the region being largely one of successive cycles of stream erosion, modified to a slight extent by glaciation of higher altitudes.

The Central Plateau is readily subdivided into areas in which one or another of the foregoing geological events played a dominant rôle in shaping the present topography. The Limousin in the west is a vast peneplane of early Tertiary age surrounding a central monadnock mass, La Montagne, the whole little affected by dislocations or vulcanism. In strong contrast, the Auvergne and adjacent regions in the center and north consist of fault blocks profoundly displaced, some raised high with surfaces generally representing the resurrected peneplane of early Tertiary age, others greatly depressed and buried under thick accumulations of Tertiary sediments; over both were spread volcanic accumulations of vast extent, including the great cones of Mont Dore and the Cantal. The southern region is especially characterized by tilted fault blocks, like the Lozère and the Montagne Noire, with back slopes formed by resurrected peneplanes of post-Hercynian and early Tertiary date; but it also includes the vast limestone plateaus of the Causses. Along the southeastern borderland the rocks of the highlands are warped and broken downward toward the Rhone Valley and the Mediterranean shore, while erosion of the depressed weak rock cover has largely determined the plateau border; here the inclined lava plateaus of the Coiron contrast markedly with the sharp crested ridges and wild gorges of the Cévennes, carved by active stream erosion on the steepened slope.

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* Henri Baulig: Le Plateau Central de la France et sa bordure méditerranéenne: Étude morphologique. 591 pp.: maps, diagrs., ills., index. Armand Colin, Paris, 1928.

It is not possible in a brief review even to mention the large number of highly important conclusions presented by Baulig respecting each of the above regions. The reader must himself follow the author through his painstaking analyses of geological history and resulting surface forms in order to appreciate the full breadth and depth of his studies.

RESURRECTED PENEPLANES

From among the more important theses which Baulig advances two are selected for special comment. The first is that a large proportion of the upland surface of the Central Plateau consists, not of a single warped peneplane of relatively recent date, but of different peneplanes which were completed long ago, buried under later sediments, and more recently reëxposed to view through stripping away of the sedimentary cover. These peneplanes usually intersect each other at a low angle, and the nearly uniform surface of a single plateau block may consist of two distinct peneplanes. Resurrection of such surfaces presents a delicate problem to the geomorphologist, especially when the resurrected forms are profoundly dissected by later stream erosion; for it is no easy matter to distinguish a single peneplane of late Tertiary age, warped to give some variation in slope and badly dissected, from two resurrected peneplanes of more ancient date, intersecting at a low angle and badly dissected. Apparently Baulig has successfully accomplished this task at many points throughout his area, for both his evidence and his arguments seem to stand the test of critical analysis.

EROSION CYCLES AND THE EUSTATIC THEORY

The second of Baulig's theses selected for comment is far more radical. It is, in effect, that a large number of erosion cycles registered in the topography of the plateau and its borderlands, and covering the long period since the late Pliocene, result from eustatic shifts of sea level, the land having remained essentially stable all this time. As the author correctly points out, the eustatic theory has a value which is independent of the extent of country to which it can with certainty be applied: "It is sufficient that there should have been, at certain periods, some stable regions in order that one may correlate with these few fixed standards the evolution of unstable regions." Accordingly the leitmotif of Baulig's work, the end to which much of his argumentation converges, is to extend to higher levels in southeastern France and to confirm for earlier geologic times the eustatic theory of changes of level advocated by de Lamothe, Depéret, Chaput, and others of the French school; and he closes his treatise with the confession of his faith that just as geologic chronology reposes upon the widespread occurrence of marine transgressions and regressions, "so it may be that upon the eustatic theory, duly verified and confirmed, morphology will one day establish universal correlations."

EROSION CYCLES REVEALED IN THE PLATEAU VALLEYS

Baulig's treatment of erosion levels falls into two main subdivisions: the cycles revealed in the valleys traversing the several parts of the Central Plateau, and the "grandes surfaces d'aplanissement cyclique" found along the Mediterranean borderland. Forms of the first category are described in various chapters throughout the book in connection with accounts of different sections of the plateau. It is found that the steams repeatedly exhibit, in longitudinal profile, a succession of steeper and more gentle segments, a steeper segment often grading imperceptibly into the next portion of more gentle slope in such manner as to give a profile concave upward. These are interpreted as the result of successive rejuvenations of the stream, the deepening and steepening due to rejuvenation having been propagated headward as successive "waves of erosion." Confirmation of this interpretation is believed to be found, in many places, in the presence of more gently graded portions of valley walls, high above present stream level, these being regarded as remnants of earlier mature valleys into which the rejuvenated stream has cut forms of a later generation. The different segments of each longitudinal profile are prolonged downstream to give the theoretical former positions of the thalwegs for each assumed cycle, the positions of the respective thalwegs being checked whenever possible by projecting appropriate facets of ancient valley walls still preserved at high levels. The various restored thalwegs on one stream are correlated with those on other streams, each being assigned to its corresponding cycle, numbered from above downwards.

It is not necessary to discuss this portion of the author's work in great detail, since Baulig himself does not seem to regard it as the strongest part of the case in favor of the eustatic theory. He rather marshals such evidence as the regions present and indicates the direction in which he believes the evidence is pointing, leaving to the erosion platforms of the southeastern border the main burden of proof. Indeed, the failure to correlate effectively the supposed cycles revealed by stream profiles in the plateau with the abrasion platforms on its border, coupled with the failure to bring out strongly the nature of the transition from one to the other and thus to emphasize their continuity of development, if such there be, seems to the reviewer a weak point in the author's argument.

But there are other weaknesses more apparent. In the introductory portion of the work, "Les Problèmes et les Methodes," the author fully recognizes that there are grave difficulties and real dangers in attempting to decipher erosion cycles from stream profiles which might be expected to contain changes of slope due to non-cyclic causes (variations in rock resistance, earth movements, stream capture, etc.). When, however, the individual profiles are examined and interpreted, it does not appear that sufficient weight is given to these difficulties. Changes of slope are accepted as cyclic in origin and assigned to specific numbered cycles, when it would seem they might equally well bear an alternative interpretation. Such an alternative interpretation is sometimes considered but rejected on grounds which appear invalid, as when it is argued that a sudden steepening of stream slope cannot have had its origin in a hard rock barrier because the break in slope does not now occur at the contact between hard and weak rock. The author in such places gives little or no weight to the fact that falls, rapids, and steepened profiles developed at a barrier will cut back into and eventually through the obstruction and may therefore be found in the midst of the hard rock zone, or in the weak rock zone next upstream, far from the contact which gave birth to them; nor does he sufficiently consider the extent to which this same history will give rise to youthful gorges cut in more mature valleys of non-cyclic origin.

In the restored profiles of supposed ancient thalwegs the proportion of known fact to theoretical reconstruction is extremely small, short remnants of actual profiles being projected through the air for great distances beyond the last trace of supporting evidence in the topography. Sometimes the restored thalwegs are carried far out above the surface of a low-lying peneplane, it being assumed that the peneplane has been developed since the thalwegs were established, or that the thalwegs were cut in an overlying weak rock cover which has since been removed by erosion. Wide variations in the angles at which the theoretical profiles are projected seem permissible without rendering them out of harmony with the small remnants of existing profiles actually observable in the field; yet even slight variations in these projections will give an arrangement of profiles requiring for its explanation a theory of origin entirely different from that supported by the author. The very assumption on which the profiles are restored—that in the same section of a supposedly "regularized" stream any given former thalweg cannot slope less steeply than earlier thalwegs nor more steeply than those of later date—seems of doubtful validity.

Baulig himself repeatedly emphasizes the delicacy of the problem and admits the necessity of extensive interpolation and extrapolation, the absence of the supposed cyclic changes of slope on certain streams and the presence of abnormal changes of slope on others which do not fit into the cyclic scheme and require special explanation; and when, further, he is unable to establish complete concordance between the cycles of different drainage systems in the same section of the plateau, the reader should at least be as cautious and leave the demonstration of the eustatic theory to a region furnishing better evidence than does the plateau upland and its streams.

On the other hand, the reader would be ill-advised to dismiss Baulig's theory from consideration simply because it presents a picture of cyclic changes very different from that recognized by most geomorphologists. If successive cycles are propagated into a still-standing continental mass as "waves of erosion" in such manner that today a Pliocene cycle of erosion may yet be in full swing at high levels and there attacking deposits of late glacial age, with cycles of various later dates simultaneously following it inland at lower levels, so as to give erosion planes of different altitudes and different geological dates of origin, *literally produced at the same time*, it is highly important that this history be fully established and that we reëxamine Appalachian and other topography with the possibilities of this theory in mind.

EROSION PLATFORMS OF THE SOUTHEASTERN BORDERLAND

So far as Baulig's treatise is concerned the case for the eustatic theory must stand or fall on the evidence furnished by the erosion platforms of the southeastern borderland, where the plateau upland breaks down toward the Rhone Valley and the Mediterranean. The author believes he can clearly distinguish three principal erosion levels: the 180-meter, the 280-meter, and the 380-meter surfaces, levels, plateaus, or cycles, as he variously calls them. Less extensive and less perfectly defined are the 150-meter and the 250-meter levels. Still lower levels are recognized, including the terraces of the Rhone Valley studied by Lamothe and Depéret; but, after an analysis which takes issue with these authors on material points, Baulig concludes that the higher surfaces, from the 150-meter level upward, are more reliable and more significant. It is accordingly upon these that he proposes to base the case for the eustatic theory.

Although the author discusses these several levels in much detail, giving a large number of specific elevations from selected localities, he does not show their extent by map or diagram. Hence the reader cannot be sure he correctly pictures the forms and their boundaries. It would appear from the text, however, that in a general way the platforms extend along the southeastern slope of the plateau border, roughly paralleling the Mediterranean and the Rhone depressions. They are described as maintaining a rigorous horizontality in this direction, although it would appear that they may slope downward from their inner toward their outer borders. The interpretation that they, or some of them, represent parts of a single warped peneplane is rejected on the ground that the forms occur in stepped series. A marine origin for the forms, previously advocated by some investigators, is excluded on the ground that the surfaces are too rugged and too systematically adjusted to drainage slopes for a plane of marine abrasion, that no sediments of marine origin are found on them, that they were developed in part in protected localities not well exposed to wave attack, and that their inner borders fail to show cliffed headlands and other shore forms. But he believes each of the platforms must have been produced close to the sea, although by subaërial processes. In age the platforms are regarded as late Pliocene and later; and because of their horizontality it is concluded that they have not been affected by earth movements during that period. Accordingly they are interpreted as the result of successive eustatic drops of sea level. To confirm this conclusion the author examines descriptions of erosion levels studied by other investigators in widely separated localities and finds a sufficient number of corresponding platforms in those places to prove, in his opinion, the validity of the eustatic theory.

There can be no doubt that Baulig has rendered important services to geomorphology in this, as in other portions of his excellent treatise. His critiques of the work of Depéret and Lamothe will be useful to all students of the problem of river and marine terraces, while his descriptions of the borderland topography and explanations of the drainage history will prove an indispensable aid to every future investigator in this region. But as to the strength of the case which the author presents for the theory of eustatic shifts of sea level opinions will doubtless differ.

Some Critical Considerations

The problem is admittedly complicated, and it is not practicable within the limits of a review to present in full the grounds which permit one, while accepting the facts stated by the author, to hesitate before adopting his conclusions. It may, however, prove useful to future students of Baulig's valuable treatise to specify here a few considerations which make the case for the eustatic theory, as presented by that author, appear unconvincing. Briefly stated, these are as follows:

1. Many essential facts necessary to a critical judgment on the merits of the case are not placed before the reader. Opinions as to the origin of the platforms, as to the accuracy with which their former and present attitudes may be determined, and other vital points must be based on more data than are offered regarding the areal extent and shape of the platforms, their exact surface form, the amount and directions of their slopes, and the extent of their preservation or of their destruction by stream erosion.

2. The method of selecting the altitude figures given for the several platforms, and especially of determining the low points for which the erosion levels or cycles are named, is not made sufficiently clear. Since methods of accomplishing this task for a partially eroded surface vary and involve variable proportions of error or personal equation, it is necessary to have a clear picture of the procedure in order to know within what limits warping of supposedly horizontal platforms may occur without being detected.

3. The mechanical regularity of the vertical spacing of the platforms (100-meters interval between the principal levels, 180, 280, 380; and 100-meters interval between the chief surbordinate levels, 150, 250) suggests that these are approximations rather than actual determinations of platform positions and raises doubts as to the accuracy with which these positions are identifiable on the dissected terrain and consequently further doubts as to the certainty with which warping or tilting of the platforms can be excluded.

4. While the platforms are said to maintain rigorous horizontality in directions parallel to the supposed ancient shore lines, the altitude figures given by the author vary so widely that it is not clear how this supposed rigid horizontality was determined.

5. Many of the supposed facts upon which the author bases important parts of his argument do not themselves appear to be adequately demonstrated. Especially open to question are his conclusions that the erosion surface beneath the Coiron lavas has not been deformed; that the régime and slope of the Ardèche and Rhone rivers have remained constant from the more ancient levels to the present; that the Rhone has fully established its profile of equilibrium; and that since the end of Miocene time the Gulf of Lyons has never had rocky shores.

6. Alternative theories are not examined with sufficient care to justify their elimination. One (the epeirogenic theory) is dismissed without discussion, on the basis of the author's personal judgment that epeirogenic movements could not raise uniformly an area hundreds of kilometers in extent. Consideration is not given to the possibility that a broad uparching of the plateau might occur in such manner as to tilt the borderland more steeply and raise its erosion platforms, yet at the same

time leave these platforms little distorted in the direction of their elongation parallel to the ancient shore lines.

7. Comparisons with other areas selected by the author for verification of the eustatic theory show that inconsistencies in platform levels are sometimes as striking, and occasionally more so, than are the cases of agreement. In some cases apparent agreement is only secured through argument (in one instance very elaborate and highly theoretical) directed to disproving the interpretations as to attitude or origin of platforms offered by those who have studied them on the ground.

8. A considerable part of the supposed confirmation of the eustatic theory consists in citations of the lower levels (below 150 meters) of Depéret, Lamothe, and others, although these were earlier explicitly excluded from the author's study for reasons apparently sound. In any case they are just as foreign to Baulig's discussion as would be the citation of his high Pliocene levels in an effort to prove eustatic movements during the early Tertiary.

Many will miss the full value of Baulig's work because in its make-up sufficient attention was not given to the highly important matter of illustrations. In all the 544 pages constituting the body of the text there are only four small diagrams, although both the subject matter and the author's manner of treating it render sketch maps and other diagrammatic representations of the facts peculiarly necessary. Surface forms, structural features, areal geology, and other important elements are described in terms of their location with reference to countless small towns or villages unknown to the average reader and not shown on any map available to him. The six large contour maps accompanying the work are of little or no help in this connection, as cities, towns, and villages are all omitted from them, no topographic features except rivers are named, and even the contour interval and altitude figures are lacking. In places the reader is aided to an understanding of the text by the plate of cross sections, but even here he is frequently baffled because most of the localities named in the text are not shown on the sections and because some of the cross sections described in the text appear to be differently located from those figured on the plate. The plate carries no explanatory legend to make intelligible the symbols employed, so the reader must turn to the descriptions of sections published in the back of the volume before he can fully understand the geological relations. Correlation between text and illustrations is very defective, a large proportion of the text failing to refer to the appropriate maps, sections, or profiles in the pocket.

For these reasons Baulig's treatise makes extremely difficult reading; to understand it fully one requires a set of large-scale topographic maps of the whole area, a corresponding set of geological maps, and patience to trace on them, step by step, the details of the author's discussion.

The reader who hurdles the difficulties placed in his path by faulty illustration lays down the volume with a feeling that he has journeyed far and most profitably with one who has given him an inspiring vision of the Central Plateau and its problems. The strength of the work depends upon the sureness with which the author demonstrates that geologic processes working upon geologic structures throughout past geologic time have produced the present topography. Its occasional weaknesses occur where the workings of geological processes and the results which they are capable of producing are too narrowly restricted by deductive reasoning based on an insufficient foundation of geologic fact. The work as a whole is excellent, and both geologists and geographers are indebted to the author for the valuable service he has rendered their respective sciences.

GEOGRAPHICAL RECORD

NORTH AMERICA

Some Recent Surveys in Alaska. "Topographic mapping in Alaska has been carried on in a systematic way by the Geological Survey for nearly thirty years, yet in that time less than half of its vast area has been covered." Southeastern Alaska in particular is a difficult terrain to explore because of its heavy rainfall and rugged relief. With the exception of the International Boundary, scattered mineralized localities, and the vicinity of towns little accurate information has been available, in spite of the wealth in mineral and timber resources that awaits exploitation. Here was an excellent opportunity to put aerial photographic mapping to the test; and such a test was carried out by the U. S. Navy, in coöperation with the Geological Survey and other government departments in 1926. A summary of the work is given in "Aerial Photographic Surveys in Southeastern Alaska," by R. H. Sargent and Fred H. Moffit (*U. S. Geol. Survey Bull. 797-E*, 1929; see also R. H. Sargent: Aerial Surveys in Southeastern Alaska, *The Military Engineer*, Vol. 20, 1928, pp. 189–195). An index map shows the area covered by the surveys—about 10,000 square miles and comprising the large islands of southeastern Alaska with the exception of Chichagof and Baranof. The first preliminary map sheet (Part of Ketchikan-Hyder Region, scale 1:250,000) constructed from the photographs also accompanies the report. This map shows drainage but not contours. The survey is now experimenting with an aerocartograph for determining relief directly from the photographs by stereographic principles (see "Mineral Industry of Alaska in 1927 and Administrative Report," by Philip S. Smith, *U. S. Geol. Survey Bull. 819-A*, 1929, p. 75).

Southeastern Alaska is well suited for an experimental air survey in that its extent of fiorded coast provides frequent landings for amphibian planes and that ground control is already provided by the charts of the U. S. Coast and Geodetic Survey. Photography was done with a tri-lens camera at a height of 10,000 feet. The flight routes, plotted beforehand, were laid across the islands east to west in order to obtain control at both ends. Weather played a predominant part in the accomplishment of the work. Only about 15 out of 90 days proved favorable for the purpose in hand, though a careful series of upper and lower air observations and the coöperation of 22 weather stations in southeastern Alaska enabled full opportunity to be taken of suitable conditions. One of the more immediate results of the survey was the plotting of forest distributions and of water power sites and the subsequent leasing of several tracts for lumbering purposes. A second aerial expedition went into the region this summer (1929.)

The "Geology of Hyder and Vicinity . . ." by A. F. Buddington (*U. S. Geol. Survey Bull. 807*, 1929) illustrates the type of detailed study made in a region where prospecting is active. Hyder, at the head of Portland Canal near the International Boundary, has been the scene of considerable prospecting since the great success of the Premier silver and gold mine on the Canadian side.

East and north of Fort Yukon lies a large area unmapped, save for the Canning River district explored by E. de K. Leffingwell, until J. B. Mertie started exploration of the Sheenjek tributary of the Porcupine River in 1926 (*U. S. Geol. Survey Bull. 797-C*, 1928). Subsequently work was carried on between the Sheenjek and the East Fork of the Chandalar, and in 1928 the survey was shifted to the territory between the Yukon and Tanana rivers.

In "Surveys in Northwestern Alaska in 1926" Philip S. Smith (*U. S. Geol. Survey Bull. 797-D*, 1929) describes the continuation of the work done in that region which has been carried on successively since 1923 when the Naval Petroleum Reserve No. 4, lying between Point Barrow and Brooks Range, was created. The primary aim of reconnaissance here was the determination of oil resources. No indications of large oil deposits have been discovered as yet; and in view of the isolation of the area and the absence of timber, food, equipment, and labor any early development of the region seems unlikely. Surveys for oil have also been carried out in the Aniakchak district of the Alaska Peninsula. The rocks exposed do not encourage a hope for any considerable supply of oil, nor does drilling seem warranted (R. S. Knappen: Geology and Mineral Resources of the Aniakchak District, Alaska, *U. S. Geol. Survey Bull. 797-F*, 1929).

Difficult of access and avoided by trappers and prospectors, the country between the Alaska Range and Cook Inlet remained one of the largest unexplored areas in Alaska until S. R. Capps undertook his present series of expeditions. In 1926 the Skwentna was topographically and geologically mapped (*U. S. Geol. Survey Bull. 797-B*, 1929). In 1927 Capps carried a survey to the vicinity of Mt. Spurr, discovering lakes, glaciers, and mountains, including an active volcano. The work of 1928 was greatly expedited by the use of airplanes, which transported about half the party to the scene of action in a few hours whereas the pack train occupied weeks in arriving at its destination.

The Need for a Sound Land Policy in the United States. "Will our land area in the United States meet the demands of our future population?" "How are we to determine the best use of our land resources?" An attempt to answer these two questions is made in a little book entitled "What About the Year 2000?" recently published by the Joint Committee on Bases of Sound Land Policy. This committee, organized in 1927 by the Federated Societies on Planning and Parks, has "brought together specialists in agriculture, forestry, physical sciences, engineering, city planning, parks, and land economics," with a view to studying the "interrelations existing between the various land uses" and to paving the way toward the formulation and execution of sound policies and programs.

The rate of increase of our population is slowing down. Recent estimates by Professors Pearl and Reed of Johns Hopkins University and by Professor Whelpton of the Scripps Foundation for Population Research in Miami University indicate that the country will not have more than 200,000,000 inhabitants in the year 2000. "Perhaps the population will never greatly exceed this number, and probably will fall 10,000,000 or 15,000,000 below it. If we read aright the forces which determine the distribution of the population, most of these additional millions will live in urban territory. . . . " It is estimated that without any lowering in our standard of living and without any increase in the acreage devoted to agriculture our farm lands could support 180,000,000 people. They could support a very much larger number if the 608,000,000 acres of potential crop land not harvested in 1919 were utilized. Therefore, "considering everything, it appears unnecessary to worry about any long-time food scarcity in this country."

Indeed, at the moment the contrary is the case. "The present agricultural crisis seems to be due mainly to overproduction caused by cultivation of more land than is necessary under modern agricultural technique, for the present market demands." Although there are doubtless local areas where additional land might profitably be put to specialized agricultural uses, students of rural land utilization are mainly interested in the submarginal areas that ought, perhaps, never to have been farmed in the beginning. Where are these areas? Shall they be withdrawn from agriculture and allowed to revert to forest? How shall they be taxed? What shall be done with their inhabitants? Shall township and county governments which include a large amount of submarginal land under their jurisdiction be consolidated into larger units? When such questions can be definitely answered in regard to specific regions and answered on the basis of sound policy that takes into consideration the best interests of region, state, and nation, we shall have advanced far toward the solution of one of the most pressing problems in the field of land planning. (See "Changes in Production and Consumption of Our Farm Products and the Trend in Population: Do We Need More Farm Land?" by O. E. Baker, *Annals Amer. Acad. of Polit. and Soc. Sci.*, Vol. 142, 1929, pp. 97–146.)

As our population increases and our economic system becomes more complex, the question of land utilization grows constantly more urgent and more difficult. "Demands for habitation, commerce, industry, farms, grazing, forests, mineral deposits, parks, highways, scenic drives, railway routes, inland navigation ways, power reservoirs, storage sites for metropolitan water supplies and irrigation of dry farming lands, and countless other uses, frequently fall upon identical or overlapping areas." The reconciliation and adjustment of these various demands and the promotion of harmonious development instead of a chaos of conflicting interests is the task of the land planner. This task demands a fundamental groundwork of facts that can be gleaned only through detailed coöperative local and regional surveys.

Problems of the American Town and Village. At the University of Minnesota there was held on June 24–28, 1929, a conference on the problems of towns and small cities. Of especial interest to geographers was the discussion on types of towns and their trends. Eight types may be recognized:

1. The village which is strictly a commercial service station for a rural community. This "cross roads" type has rather generally lost population, and many of the smaller villages, especially those not on a railroad or a main trunk highway are apparently likely to continue to decline. It is believed that many of them will practically disappear, because with automobiles and good roads an increasing percentage of the former patrons go to a larger town to make purchases and sales.

2. If these rural service stations have the advantage of railroad service or if, because of poor roads and considerable distance, it is not convenient for the farmer to go to larger towns, these small towns may continue to serve their locality but with little prospect of growth.

3. County seats. Most county seats are growing, at least slowly, as, now that automobiles are numerous, county seats serve a larger and larger area and have come to be the commercial as well as the political center of their county.

4. Most college towns are growing, with the increased popular demand for higher education. Most college towns are also county seats.

5. The towns which serve as service stations for the extractive industries, lumbering, mining, oil wells, fishing, are mostly declining—with the depletion of the source of wealth or because of increased competition of other areas. Many such towns have almost disappeared. In newly developed regions, however, such towns are growing, sometimes very rapidly.

6. Resort towns. With the great increase in the vacationing habit, associated with the increased use of the automobile, most resort towns are growing, and many villages are being benefited economically by the tourists.

7. An increasingly important class of towns is the residential suburbs of cities. These have increased greatly in number during the last quarter century with the improvement of transportation facilities. This type of town is experiencing a rapid and substantial growth.

8. Another distinct class of town is the small manufacturing community. Such towns arise in three ways: a large industry may establish decentralized units and build new towns for the purpose; the industry of the town may be the processing of the crops of the surrounding territory, for example, pea, corn, tomato canneries. Similarly, meat-packing plants are established to process products locally produced. A third sort of manufacturing town develops around the nucleus of some light in-

dustry or the manufacture of some specialty for which transportation costs are of minor importance. Some of these manufacturing plants are of local origin; but an increasing number are branches of factories or are factories that have moved from large cities to smaller towns.

During recent years considerable decentralization of manufacturing has occurred, and certain types of industries have increased more in towns and small cities than in large cities. For example, between the censuses of 1920 and 1924 (general and manufacturing) there was actually a decline in the number of workers engaged in industry in the cities of over 10,000 population, but there was a gain in the number in cities of less than 10,000. This is partly because the industries of the smaller cities are largely those employing much labor, while in the large cities labor-saving devices are increasingly used. The town and small city are favored over the large city also by the movement toward the integration of industry. Increasing recognition of the importance of favorable environment for employees is working in the same direction.

Specialization in manufacturing or other activity has occurred in some towns and small cities, and might advantageously be achieved elsewhere. Newton, Ia., is "the washing machine center" of the world, with four factories, one of which does a huge business. Connersville, Ind., manufactures most of the world's rotary pumps; and Alexandria, Ind., much of the mineral wool.

Although, of course, most towns must remain of negligible importance industrially, they can be kept on an economically sound basis if there is wise planning and a reasonable amount of coöperation. Statistical studies have disclosed what kinds of service institutions (stores, banks, professional men, etc.) and how many of each kind can be profitably maintained in towns of various sizes and types. Much good has already come to some towns by the dissemination of this sort of information, and by the effective pointing out of the benefit of coöperation, so that somewhere in each area the more urgent needs of the people can be supplied. The development of chain stores is helping many towns and small cities by providing a wide choice of standard merchandise at prices comparable to those found in the large cities.

An interesting phase of the conference dealt with the social value of American towns. Study of questionnaires filled out by 19,000 persons listed in "Who's Who in America," and by 9000 leading business men, and a study of biographical data concerning various other types of American leaders disclosed that in proportion to population the towns contributed several times as many leaders of almost all sorts as did the rural districts, and considerably more than did the large city. This may be due to superior advantages present for the development of leadership, for instance, towns affording closer social contacts than do either the farm or the large city. The town is also more convenient for experimentation in business and professional activity and individual leaders (teachers, preachers, business men) have more influence than all but the very exceptional leaders in the large city. More leaders were born in college towns and county seats than in other towns in proportion to population (except residential suburbs of large cities).

Another possible explanation of the superiority of towns in yielding leaders is that biologic selection has occurred. In the drift from country to city the first step is often the town. If a considerable share of the more alert people leave the farm for the town where their talents can be better employed and where their children will have better opportunity for an education, then, of course, the town should yield more leaders than the country if leadership depends largely on inherited ability. The large cities attract not only the more capable people from the country but also many of the less capable, as well as many manual workers from foreign lands.

Good descriptions of American towns and small cities are to be desired. Such descriptions are available for a number of large American cities; but the smaller urban communities have received only incidental consideration from most American geographers. An exception is Robert S. Platt's "A Detail of Regional Geography: Ellison Bay Community as an Industrial Organism" (*Annals Assn. of Amer. Geogrs.*, Vol. 18, 1928, pp. 81–126). On the other hand we have some excellent town studies by sociologists, for instance N. L. Sims's "A Hoosier Village," (1912); J. F. Steiner's "American Communities in Action" (1925), and "Middletown" by R. S. Lynd and H. M. Lynd (1929). Sims describes his home town of Angola in northeastern Indiana, showing the interplay of geographic and non-geographic factors from the foundation of the village in 1835 to 1912. Steiner's "American Communities in Action" describes twenty towns, representing types scattered over several states, mostly in the South. Although the descriptions are less full than that of Sims, they too are by persons intimately acquainted with the towns, as each is by a graduate student of Professor Steiner of his own home town.

"Middletown" is an analytical description of Muncie, Ind. Although there is little formal geographic description, the setting is well given, careful attention is given to the effects of the discovery of natural gas and oil, to the improvement of transportation facilities, and to the development of other urban centers. Also attention is given to the local conditions within the small city which have led to contrasts in the types of residents and residences. This study of Muncie resembles Sims's "A Hoosier Village" in being a scholarly sociological study but differs from it in various significant ways. One is that Dr. Lynd, his wife, and other trained assistants went to Muncie as strangers and spent somewhat over a year in making a formal investigation which was financed by the Institute of Social and Religious Research of New York. The Lynds did not attempt to study conditions earlier than about 1890, while Sims traced the development of his village from its very inception. As Muncie is now much larger than Angola, its life is much more complex and social relations are much more predominant.

The Institute which financed the study of Muncie has contributed several valuable studies of American villages (population 250–2500). C. L. Fry has published five detailed statistical analyses of 177 scattered villages based on the returns of the 1920 census. In his "American Villagers" (1926) he sums up the findings of these analyses and other studies and presents some interesting conclusions, one of which is that one-eighth of the American population reside in villages and that the percentage is increasing. The 140 agricultural villages of the 177 just mentioned receive detailed attention in "American Agricultural Villages" by Brunner, Hughes, and Patten (1927). In Brunner's "Village Communities" (1927) the director presents a good summary of the institute's studies of villages.

The relationship of the village and the rural community, and various other problems of villages are well described in H. P. Douglass: "The Little Town" (1919). His book "The Urban Trend" (1925) is also of value. "Urban-Rural Relations," edited by Taylor and Frame (1928), and especially "Principles of Rural-Urban Sociology," by Sorokin and Zimmerman (1929), also merit consideration by those interested in American towns and small cities.

S. S. Visher

The History of the Trans-Mississippi West. "The History of the Trans-Mississippi West" was the subject of a conference held from June 18 to 21 inclusive at the University of Colorado. The program, consisting of round table discussions together with lectures, touched upon all significant phases of western economic and social history and was full of geographic interest.

A number of papers were designed to fill gaps in order to add strength to the present store of factual information about the West. Such was the paper by Colin B. Goodykoontz on "Home Missions and Education," which supported Turner's early generalization that the East attempted to regulate the frontier through educational and religious activity. The papers by LeRoy R. Hafen, "Handcart Migration

Across the Plains"; John Carl Parrish, "By Sea to California"; and Louis Pelzer, "Trails of the Trans-Mississippi Cattle Frontier," constituted a series on methods of western travel. In "The Great Plains and the Industrial Revolution," Walter Prescott Webb pictured the semiarid country largely defying settlement until, aided by the Colt revolver, barbed wire for fencing, drills, windmills, and farm machinery, the American pioneer was able to develop a new technique in a new environment.

Other papers put forth new interpretations of old tenets. Herbert E. Bolton, in "Defensive Spanish Expansion and the Significance of the Borderlands," maintained the thesis that, contrary to prevailing opinion, Spanish colonization was notably successful; the peninsulas of Spanish control north of the Rio Grande later to be relinquished being considered chiefly the tenuous military and religious outposts of a vast Spanish domain to the South. "The West in Foreign Relations," by Eugene C. Barker, dealt with the boundary controversies growing out of the Louisiana Purchase and the methods and motives of the United States in the acquisition of California and the Southwest and proved to be a refreshing treatment of what might seem to be a threadbare theme.

Not a few papers raised new problems and discussed possible lines of further investigation, and in many of these projects the geographer's aid is implied. In his "Finance and the Frontier," Frederic L. Paxson suggests that groups of frontier people may be studied with greater ease than people in older societies and presents an impressive list of problems in frontier finance which should be studied in this connection. Joseph C. Schafer considered the problem of the regional rural survey with which type of study he has been so largely successful in Wisconsin. He suggests that in the absence of other less dependable documentary matter the Western historian must seek the Federal Land Survey, the Soil Survey, and the census schedules if he is to lay a solid foundation for the history of settlement in given communities.

A session avowedly devoted to geographic aspects of Western history was led by Carl Sauer. He outlined the field of historical geography as being chiefly concerned with the series of cultural forms by which man has given a succession of imprints to an area, or "the succession of cultural landscapes and their explanation." The American Indian is thus regarded as the original pioneer. To the white settler, who in part at least appropriated the trails and village sites of the Indian, the all-important question was the balance of resources which made possible his self-sufficiency, especially the vegetation cover and soil fertility. To study the frontier or plurality of frontiers formed in the westward movement, the reconstruction of the preëxistent vegetation is a necessary first step, because this factor was of greatest moment to the pioneer and largely determined the character of the frontier.

Ralph H. Brown

The Virgin Islands of the United States. The economic future of the Virgin Islands of the United States has become a real problem. There is a continual unfavorable balance of trade; imports in 1927 amounted to $2,501,000 while the value of exports only reached $1,144,000. Shipping is attracted to these islands by their strategic position midway between Key West and the Panama Canal and by the excellent harbor of St. Thomas, which is largely dependent on bunkering, repairs, and trans-shipments.

Sugar is the chief product of the Virgin Islands. Although the advantages of the United States tariff make it a profitable crop, the mountainous character of St. Thomas and St. John islands are unfavorable, and the cultivation is confined to the fertile plains of St. Croix. Unfortunately, the crop here is limited by the distinctly variable rainfall, and there is small hope of increasing the sugar acreage through irrigation, for the geological formation of the island is unfavorable (R. S. Tucker: Economic Conditions of the Virgin Islands, *69th Congr. 1st Sess.*, *Senate Doc. No. 41*, Washington, 1926).

Cotton, formerly of considerable significance, has disappeared as a cash crop on account of the ravages of the boll weevil. Raising cattle for the Porto Rico market has become an important activity particularly on the hilly islands of St. Thomas and St. John. Manufacture of bay rum is the only industrial activity—the finished product amounts to about five per cent of the total exports. There is a ready market in the United States, and exports are increasing; but the industry is dependent on Porto Rico for most of the raw constituents.

An adequate labor supply is one of the economic problems of the island. For many years population has been declining. An estimate places decline from the time of the first census, 1823, to 1917 at nearly 40 per cent. In spite of efforts made since 1917, decrease has continued through emigration into the United States, which is now practically unrestricted. Recently Porto Ricans have been imported to solve the labor shortage cause by emigration and the low efficiency of the natives.

In the face of such conditions the economic future of the islands would seem to lie along new paths. A report by the Governor ("The Virgin Islands of the United States; A General Report by the Governor," Navy Dept., Washington, 1928) offers two solutions. The first of these is a diversification of agriculture by the introduction of market gardening. Onions, egg plant, peppers, and tomatoes have been sent to the New York market with some success (see "Report of the Virgin Islands Agricultural Experiment Station, 1927," [*Publ.*] *Virgin Islands Agric. Exper. Sta., St. Croix*, U. S. Dept. of Agric., Washington, 1928). Although in its early stages and needing careful management, there seems to be a real future for this industry. The second solution, development of the tourist industry, has hardly begun—accommodations being almost completely lacking. The climate is well suited to the requirements of a winter resort, and the islands have a picturesque background both natural and historical (see M. E. Brooke: Casual Glimpses of St. Thomas, the Island of Blackbeard and Bay Rum, *Bull. Geogr. Soc. of Philadelphia*, Vol. 27, 1929, pp. 43–53). Three regular lines of passenger steamers now touch at the islands, and an increasing number of Carribbean tours call at the harbor of St. Thomas (see W. L. Thompson: The Virgin Islands of the United States, *U. S. Naval Inst. Proc.*, Vol. 55, 1929, pp. 289–295).

SOUTH AMERICA

Urban Development in South America. Historical forces of widely divergent origin have given the larger cities of South America their outward form and inner character. The early town, with central plaza and straight, narrow streets laid out in rectangular pattern, was often modeled upon the town plans of Spain and Portugal, and these in turn owed much to the Roman *castra*. The low-roofed dwelling surrounding a court was also borrowed from Mediterranean lands. From the Europe of the mid-nineteenth century, particularly from Paris, came the broad, tree-lined boulevard and the ornately decorated neo-Renaissance architecture of public buildings. At the present time the North American skyscraper is making its appearance.

The last betokens a mighty change now in progress throughout Hispanic America. "The typically national, traditional city" is fast giving way to the international metropolis. The population of Rio de Janeiro and of Buenos Aires in 1925 had reached 1,500,000 and 2,000,000 respectively. Increase in the population of the larger cities—especially of the capitals—has been relatively more rapid than that of each nation as a whole. In Uruguay 18 per cent of the population lived in Montevideo in 1875, and 28 per cent in 1925; in the Argentine the corresponding increase in the percentage of the total population living in the capital was from 10 to 20; in Chile, from 8 to 13; in Paraguay, from 6 to 11; in Brazil, Bolivia, Peru, and Venezuela, from 3 to 4; and in Colombia from 1 to 2. In Ecuador alone was there a decrease: 9 per cent of the Ecuadorians lived in Quito in 1875 and only 5 per cent in 1925. The recent change in urban character, however, is not a mere question of absolute or relative size. South America is becoming industrialized, and industrialization has meant not only the growth of manufactures but a flood of immigration and foreign control of nearly all economic functions except those of agriculture. Most of the recent immigrants are city-bred. On arrival they take up their residence in the metropolitan centers or else float back to them after short sojourns in the provincial towns. Foreign labor, foreign capital, and foreign industrial management are thus producing not only material growth but a more international character in the larger cities of South America.

These urban trends are clearly described in a recent article by Dr. Wahrhold Drascher in *Mitteilungen der Geographischen Gesellschaft in Hamburg*, Vol. 39, 1928, pp. 64–86.

The Control of Yellow Fever in Brazil. It is reported that Christopher Columbus discovered yellow fever when he discovered the new continent. In 1701 it was introduced to Europe by the Spaniards, and its appearance half a century later on the west coast of Africa may have been a result of the North American slave trade. Though climatic conditions are favorable, yellow fever has never become established in Asia. (M. Marchoux: La fièvre jaune, *Congo*, Vol. 1, 1928, pp. 348-365.) The disease is transmitted through the mosquito *Aedes aegypti* (or *Stegomyia fasciata*), and is potentially endemic only where the temperature remains above 20° C. throughout the year. Where the temperature is above 20° for a part of the year it may be epidemic. In 1900 it was endemic along all the tropical coasts of the Americas and along the west coast of Africa.

Aedes aegypti is a domestic mosquito, thriving only near human habitation. It was hoped that, by exterminating the mosquito near centers of population, it would automatically die out in the rural districts. In 1918 the Rockefeller Foundation in coöperation with the national governments began a campaign against yellow fever in the western hemisphere. A similar campaign was initiated at Lagos in Nigeria in 1925. For the year 1925 but three cases of yellow fever were reported in the Americas by the Rockefeller Foundation (G. E. Vincent: The Rockefeller Foundation: A Review for 1925, pp. 13-17), and it was hoped that the disease was completely under control. In 1926 a revolt broke out in northern Brazil, and fleeing rebels were pursued by Brazilian troops into the interior of the country where the fever was still endemic. The soldiers introduced the fever to the coast cities; and mild, undetected cases among those who returned to Rio de Janeiro were probably responsible for the epidemic of 1928 in the capital. A recent number of the Archivos de Hygiene of the Brazilian Department of Public Safety (Vol. 3, No. 1, 1929) attributes the development of this epidemic to a relaxing of the campaign against mosquitoes, combined with unusually warm temperatures during the first quarter of 1928. Investigations of the Rockefeller Foundation (G. E. Vincent: The Rockefeller Foundation: A Review for 1928, pp. 26–34) indicate that, in Africa at least, yellow fever may be transmitted by agents other than *Aedes aegypti* and that it may remain active in the interior of the countries even when under control in centers of population. This enlarges the field of search for the cause of yellow fever and postpones to a future date its complete control.

EUROPE

Swiss Colonization in Depopulated France. The worst spot in France for childlessness is Armagnac, the heart of Gascony. About halfway between the Bay of Biscay and the Mediterranean the famous detrital cone of Lannemezan gives the Adour and the southern tributaries of the Garonne their singular, divergent, fanlike pattern. They are deep sunk in the surface of the cone, on the crests of whose interfluves are perched the villages of Gascony. This is d'Artagnan's country.

The two departments Gers and Lot-et-Garonne, together making up Armagnac, have 141 and 147 births a year to ten thousand inhabitants. With mortality in France always above 173, so low a birth rate must depopulate the countryside. This depopulation is made very real in a study by Hans Bernhard, "Landbauzonen, ländliche Entvölkerung und landwirtschaftliche Einwanderung in Frankreich, mit besonderer Berücksichtigung der schweizerischen Ansiedlung in Südwestfrankreich" (*Schriften der Schweizerischen Vereinigung für Innenkolonisation und industrielle Landwirtschaft*, No. 35, Zurich, 1927).

The climate is admirable, the region fertile. The prunes of Agens and the brandy of Armagnac are widely appreciated. Table grapes, early vegetables, and tobacco provide cash crops, and the country is the best in France for grain and wines. To its excess of good things has been ascribed a condition which seems to inspire the inhabitants to the least possible effort. This notion of Gascon laziness Bernhard dispels most effectively in his picture of daily life on a modern Gascon farm. "The peasant family of southwestern France works hard, and the wife does almost more than she can endure."

It happens that an American author, Jay William Hudson, has been drawing charming pictures of this same country about Gers. "A vast rolling expanse of valley and hill, valley and hill, great waves of countless hills one after another, breaking into the spray of trees on the summits; and on every summit an ancient village, with the church tower rising above the little clustered houses, the good gray guardian of a long past and the symbol of a dream. There are the fields, many of them vineyards, sloping in every direction, and of every geometric pattern, bordered with hedges, dotted with white-walled houses, their red-tiled roofs mellowed brown by time; trees everywhere, none so conspicuous as the tall, upstanding poplars, following the devious ways of the little streams; everything green, green, green, except the winding, white roads, leading up hill and down hill and far away toward the lofty Pyrenees, just visible through the delicate, violet haze that floats along the southern edge of the world like a thin veil . . . its rolling hills all traced out into designs by the roads and hedges, it is like an undulating tapestry" (J. W. Hudson: Abbé Pierre, New York, 1928, p. 17).

In this charming landscape farms are abandoned in every direction, the buildings falling into ruin, and the fields growing up to weeds and furze. There has been death of childless couples, and there has been drift to the city as everywhere in France and in other countries. The cause of the low birth rate Bernhard finds in the prevalent ideal of the minimum family. Other things helped. In the seventies the Phylloxera came here. Nearly a million hectares have gone out of grapes since that time. Railroads are insufficient and give poor service. Many of the roads are impassable. It is not easy to get crops to a market. But mainly the people preferred not to have children.

Naturally the price of farms is very low. When the franc took its downward plunge in 1922, the Swiss peasant, who must pay $600 to $800 an acre for farms at home—buildings included, could get them here for $75 to $120, and one of his francs was worth four French ones. As this opportunity came at a time of industrial depression in Switzerland, when unemployment was increasing from 6000 in 1920 to 58,000 in 1921 and 67,000 in 1922, while in the United States the imposition of the quota cut down the increasing Swiss immigration from 8000 to 4000, it is not to be wondered at that Swiss with large families took up farms in Armagnac, buying them, renting for cash or on shares, and even took up farm work as hired families in that excellent market for farm labor, while looking for a chance to get a farm of their own.

Bernhard's volume is full of statistical data, a little confusing at times in their abundance, giving a complete account of the population and agriculture of France. For the Swiss settlers in Armagnac he found little information available and spent three months on the ground in the spring of 1926. His results come from personal observations and direct questioning of as many settlers as possible. He was well received and has been able to draw a picture of an adventure in immigration that should be gratifying to both France and Switzerland.

MARK JEFFERSON

Glaciological Research in the Horung Massif, Norway. With several collaborators and assistants Professor Hans W. Ahlmann has carried out studies since 1918 on the physiography, meteorology, hydrography, etc. of the Horung Mountains (61½° N., 8° E.) near the head of the Sognefjorden in western Norway (H. W. Ahlmann, A. Tveten, J. Eythorsson, and E. Lindskog: Physio-geographical researches in the Horung Massif, Jotunheim, *Geogr. Annaler*, Vol. 5, 1923, pp. 51–58; Vol. 9, 1927, pp. 9–66; Vol. 10, 1928, pp. 1–66). The Horung Mountains attain altitudes of 2000 to 2400 meters and are deeply dissected into ridges and sharp peaks by ice-worn cirques and valleys. They carry several glaciers, which to a considerable degree are nourished by formation of hoarfrost during high winds from the sea.

His observations on this factor lead Dr. Ahlmann to suggest that as regards the maritime regions of northwestern Europe "the formation of hoarfrost possibly may have played a great part in glacier formation during the Ice Age" (H. W. Ahlmann: On the Formation of Hoarfrost and Its Relation to Glacial Growth, *Journ. of Geol.*, Vol. 37, 1929, pp. 275–280). The transformation of snow into firn and ice was found to consist mainly in sublimation. The increase of the summer precipitation for every 100 meters altitude is about 10 per cent of the precipitation at the base, while the average increase per 100 meters altitude on the Norwegian south coast is about 15 per cent, on the west coast about 13 per cent, and on the coast from Ålesund to Lofoten 17 per cent of the rainfall at sea level. The daily variations in the run-off of the glaciers were greatest in the beginning of August and smallest during the last days of autumn. They followed the variations of the air temperature fairly well. The greatest run-off was in July. The Styggedal glacier, which was in a state of equilibrium during the years of investigation (1923–1926), flowed at a somewhat greater rate in summer than in winter, though the rate of flow during the summer was variable.

ERNST ANTEVS

AFRICA

Progress in East African Meteorology. The establishment in January last of a Joint Meteorological Service for British East Africa is an event of significance in itself and in its implications (A. Walter: Note on the Inauguration of a Joint Meteorological Service for British East African Territories, *Memoirs No. 1*, Nairobi, 1929). The East Africa Commission's Report of 1925 (Cmd. 2387) made clear the need for "greater coöperation and understanding" between the several administrative units. The Committee on Closer Union of the Dependencies in Eastern and Central Africa (Cmd. 3234, 1929) has carried things a stage further with its definite recommendation of a "Central Authority" for administrative policies and for coördination of services of common interest. The political problem is truly difficult, as Mr. J. H. Oldham, a member of the Commission, emphasizes in a recent discussion of the Report (*Journ. Royal Inst. of Internatl. Affairs*, Vol. 8, 1929, pp. 227–259). It must be solved before the closer economic union that is desirable can become a reality. Meanwhile steps towards coördination can be taken in the field of scientific research; and in the new meteorological service lies an exceptional opportunity, for it is closely tied in with the projected air services. As the Commission states, "great possibilities for the future of communications as a help towards administrative union lie in the development of air routes."

The dependence of commercial aviation on organized meteorological services has already become a familiar state of affairs. Less has been heard of the correlative—the impetus given to theoretical meteorology. The East African region lying athwart the equator and having available stations ranging in altitude from sea level to over 10,000 feet is a zone of particular importance from the standpoint of the general circulation of the atmosphere. Also it offers interesting problems of its own. It is proposed to make a special study of the problems connected with the rise and fall of the lakes and the Nile flow, and of the "possible influences of forests on what appears to be a progressive desiccation of Africa."

The Service covers Kenya, Uganda, Zanzibar, Tanganyika, and Northern Rhodesia. Egypt and the Sudan also contribute funds to the support of the undertaking. Portuguese East Africa, Southern Rhodesia, and the Belgian Congo have promised coöperation; and Seychelles, Mauritius, and Madagascar are also expected to send telegraphic reports, so that a system of forecast and warning can be applied to the adjacent waters. Five stations of the first order are being set up: at Nairobi (central office); Port Bell, Uganda, where it is also proposed to establish a base for the Air Services; Tabora; Zanzibar; and Mazabuka, in the Kafue Basin of Northern Rhodesia. Some forty stations of the second order are projected. The creation of this service should go far towards removing the reproach on Africa's backwardness in meteorology to which Mr. Jan Hofmeyr alluded in his inaugural address to the British and South African Associations in Cape Town in July ("Africa and Science," *Nature*, No. 3117, Vol. 124, 1929, July 27, Suppl., pp. 135–145; esp. p. 140).

Diamond Deposits of Little Namaqualand. The discovery of a small diamond north of Port Nolloth in February, 1926, revived an interest in and attracted a flood of prospectors to the desert coast of Little Namaqualand. Within a year the fact was established that a vast diamond field extended from the mouth of the Orange to the south bank of the Groen River, a distance of over 200 miles (Percy A. Wagner and Hans Merensky: The Diamond Deposits on the Coast of Little Namaqualand, *Trans. Geol. Soc. of South Africa*, Vol. 31, 1929, pp. 1–41). The diamonds occur for the most part in marine shingle deposits of the coast terraces, concealed beneath a mantle of sand and other surface material. In this respect they are at a disadvantage as compared with the Southwest African field which benefits by the powerful action of the south-southwesterly winds. "Were wind velocities of the order of those experienced in South-West Africa prevalent in the part of the littoral under discussion, the Namaqualand diamond fields would be without doubt the most easily worked in the world as in that case the finer surface detritus would all have been blown away."

The richest workings are at Alexander Bay, a short distance south of the mouth of the Orange River. The stones here are unlike those of the Southwest African fields, and some of them, of great brilliance and purity, are unlike those found anywhere else in South Africa. What is the origin of the diamonds of these new fields? As in the case of the "Diamond Coast" north of the Orange River, three sources have been predicated—from the interior, either from Griqualand West or the Orange Free State, brought down by the Orange River, or from local primary sources brought down by local rivers, or from some submarine source.

The interior of South Africa is an extremely old land mass and has suffered an enormous amount of denudation. During past times of heavier rainfall tributaries of the Orange River previously drained much larger areas than they do today, and dry valleys like the Brak, which may contain water but once in a lifetime, carried swiftly flowing streams of considerable volume (W. A. Humphrey: The Changed Conditions of Namaqualand, *Trans. Royal Soc. of South Africa*, Vol. 14, 1927, pp. 219–224). In the interior diamonds occur in the pipes of extinct volcanoes. The area of diamond bearing pipes and the extent of denudation are enough to account for the diamond deposits of the coast. This theory of the origin of the diamonds is supported by E. J. Dunn in "Diamonds in South Africa" (*Geol. Mag.*, Vol. 66, 1929, pp. 334–336). But the diamonds found near the mouths of the Kamma, Buffels, and Groen rivers are unlike each other and differ from those discovered near the mouth of the Orange River. The upper reaches of the Kamma and Buffels rivers have been prospected, but no diamonds have been found away from the coast.

Messrs. Wagner and Merensky maintain a conservative attitude towards this difficult problem. After pointing out pros and cons for the various theories, they conclude with the interesting comment: "All that can be said with certainty is that, except for those found in certain occurrences at the mouth of the Orange River, the diamonds of these remarkable Namaqualand deposits were cast up by the sea at a time when the coast stood considerably lower relatively to the sea than at present, and there was a warm northward current off it in place of the present cold Benguela current." As regards the prospects of the fields they are likewise cautious, but they observe that the good quality of the Namaqualand stones will do much to restore the prestige of the South African diamond industry which has been lowered recently by a large production of inferior stones from certain mines and from the enormous output of the Lichtenburg alluvial deposits in the Transvaal. The latter were discovered in 1926 and, as Dr. Wagner states in the volume of the Handbuch der Regionalen Geólogie on "The Union of South Africa" (Heidelberg, 1929), supported in April, 1927, a population of 50,000 Europeans and 90,000 natives.

ASIA

Archeological Air Photography in the Middle East. A thousand miles of country and five thousand years of human progress were spanned by Mr. O. G. S. Crawford in his recent trip to the Middle East (Air Photographs of the Middle East, *Geogr. Journ.*, Vol. 73, 1929, pp. 497–512). Mr. Crawford's pioneer work in archeological air photography is well known. Reference to his application of aerial survey as an aid in prehistoric geography of southern England has been made in the *Geographical Review* (Vol. 13, 1923, p. 616). Since then "Wessex from the Air" has appeared, written in collaboration with Mr. Alexander Keiller (Oxford, 1928). This is a collection of fifty striking aerial photographs of archeological sites within a thirty-mile radius of Stonehenge. The photographs are beautifully reproduced and accompanied by a descriptive text prefaced by a brief introduction on the history and bibliography of archeology from the air. Many archeological aerial photographs have also appeared in *Antiquity*, of which journal Mr. Crawford is editor.

Mr. Crawford's recent trip was undertaken to establish the basis for a permanent collection of archeological air photographs. How successfully his mission was filled is indicated by the fact that he brought back with him several thousand negatives taken by the British Air Forces in Egypt, Trans-Jordan, and 'Iraq. These have been deposited in the British Museum. Their value may be gauged by the examples illustrating his article. For special treatment three types of ancient town plans in 'Iraq were here singled out. The ruins of the Abbasid city of Samarra stretch for 20 miles along the Tigris. Hatra is a fine example of a Parthian site 75 miles northwest of Mosul. A mosaic of this site taken in "five minutes" helps to fill in the plan executed by Andrae in 1908 after weeks of work on the ground. Seleucia is a Macedonian site whose exact location has been in debate. "What is plainly the correct site was discovered and photographed by Squadron-Leader Insall, and it may well prove to be one of the classic achievements of aeroplane observation and photography." Passing briefly over the antiquities of the Syrian Desert and Trans-Jordan Mr. Crawford concludes with a notice of Masada overlooking the western shores of the Dead Sea and famous for its siege of 72 A. D. The siege works are well preserved, and "every detail of internal plan is plainly recorded." (See also photographs accompanying Christopher Hawkes: The Roman Siege of Masada, *Antiquity*, Vol. 3, 1929, pp. 195–213.)

Mr. Crawford makes the important point that "air photography will eventually enable ancient sites to be classified chronologically from their external appearance"; and his last word is that "the future of exploration, and not only of archaeological exploration, is literally in the air."

Russian Expansion in Asia. In "Russian Imperialism in Asia: Its Origin, Evolution and Character" (*Slavonic Rev.*, Vol. 8, 1929, pp. 28–47), Prince A. Lobanov-Rostovsky gives an illustration of what Mackinder has termed the transparency of history to the underlying facts of geography. He draws a distinction between "natural growth" and imperialism, regarding the former as a spontaneous movement on the part of the people of the country, the latter as action dictated by the government. Russia, once her energies were directed eastward, moved smoothly over the vast "no man's land" of the Eurasian plain, the "Great Lowland" permitting a mobility almost equal to that of the sea. Natural expansion was stopped by the barrier of the Hindu Kush–Pamir–Tian Shan–Gobi–Khingans. Where Russia attempted to break across the barrier and penetrate the buffer states between herself and China, expansion took on imperialistic form, whether in search of an outlet to the free sea through Manchuria, or to tap the inner markets of Mongolia and Dzungaria (Chinese Turkestan or Sinkiang), or to divert revolutionary tendencies at home.

Between Russian expansion over the plain eastward in Siberia and southward in Central Asia there is, however, considerable dissimilarity. In "The Soviet Muslim Republics in Central Asia" (*Journ. Royal Inst. of Internatl. Affairs*, Vol. 7, 1928, pp. 241–255) Prince Lobanov-Rostovsky deals with present conditions in Central Asia. Russian conquest of that region dates only from the latter part of the past century. Turkestan may be looked on as an oversea colony, sand being substituted for water: "it takes over two days for the express to plough through the great desert of Kizil Kum which forms the gateway between Russia and Turkestan." Moreover, climatic conditions are exotic and, especially in the far south—the old Khanates of Khiva and Bukhara—the land is alien, fit rather for economic exploitation than for colonization. The three significant facts of Russian occupation in Turkestan are the comparatively small number of Russians—600,000 out of a total population of over 8,000,000, the hold secured by the railway system, and the value of the cotton production.

Before the war the cotton of Turkestan together with that of Transcaspia furnished the greater part of Russia's needs. As a result of the upheavals after the war, production has declined; but its revival is one of the major concerns of the Soviet government today. In 1924 the political organization of the country was entirely reformed, new Soviet Republics being created on an ethnographic basis. The strong control exercised by Moscow is economic as well as political. Among other economic provisions is one placing the cotton-growing industry under the direction of two limited companies with the majority of the shares subscribed by Moscow. On a similar basis limited companies have been formed for the correlative importation of wheat and for the silk and wine industries. Irrigation also has been placed under a special section of the Moscow Soviet of Labor and Defense.

Of great importance is the new Turkestan-Siberian railway, now under construction. When completed, the line will unite Tashkent and Novosibirsk via Semipalatinsk and the eastern end of Lake Balkash; 1931 is the date set for completion. It is expected that a wave of colonization will follow, coming not from the northwest in the traditional way but from the northeast, that is from Siberia. It is a mistake to assume that Siberia is very much underpopulated, says Prince Lobanov-

Rostovsky. The best land along and around the Trans-Siberian Railway is already occupied. "The new settler has either to turn north into the arctic waste or attempt to conquer the Taiga, the great virgin forest which in the power it opposes to the pioneer is comparable only to a tropical jungle." Pre-revolutionary figures leave no question as to the great expense of colonization in the steppe-forest belt as compared with the steppe and in the *taiga* as compared with the steppe forest (B. N. Zhdarov: Effectiveness and Costs of Inland Immigration, *North Asia: Journ. of Soc. Sci.*, No. 4, 1928 [in Russian]). Settlers will tend to follow the line of least resistance, and that will be to the rich steppes of Kazakistan south of Lake Balkash. In addition to agricultural resources the railway will open up an area of considerable mineral wealth. Statistical data on the railway and its tributary area are given in an article by A. U. Rudzyt, "The Turkestan-Siberian Railway" (*ibid.*, No. 2, 1928, pp. 5–34, of which an abstract appears in *Soc. Sci. Abstracts*, Vol. 1, 1929, p. 392).

Agricultural Afghanistan. "Afghanistan with the adjacent countries, especially the districts of North-Western India is one of the most important primary world agricultural centers. With regard to the diversity of club wheats, as well as of the whole group of soft wheats in general, Afghanistan occupies the first place among all countries of our planet." Such are the conclusions of Professor Vavilov, who in 1924 made an extensive study of this one of the five principal world centers of distribution of cultivated plants as established by him in his "Studies on the Origin of Cultivated Plants" (Leningrad, 1926; reviewed in *Geogr. Rev.*, Vol. 17, 1927, pp. 693–695). His expedition, traveling about 6000 kilometers, covered the whole of agricultural Afghanistan including the isolated region of Kafiristan, where the inhabitants, fearing the hostility of their neighbors, cultivate their crops in practically inaccessible heights. In addition to proving Afghanistan the center where the forms of soft wheat have originated, the expedition found a weed rye and traced the whole process of the introduction of rye into civilization (see N. I. Vavilov and D. D. Bukinich: Agricultural Afghanistan; *Bull. of Applied Botany, of Genetics and Plant-Breeding, Suppl. 33*, Leningrad, 1929. In Russian with English summary).

These genetic studies, however, represent only a part of the comprehensive program of the expedition. Crops and systems of native agriculture were studied with, as ulterior object, the furthering of economic relations between Afghanistan and the U. S. S. R. In particular, attention was paid to irrigation and cotton growing. It is suggested that "the construction of the Turkestan-Siberia railway will supply Afghanistan with cheap wheat from Siberia and thus free the acreage now under the wheat for the cultivation of a more precious crop."

In Afghanistan primitive forms of agriculture exist side by side with an intensified practice which employs fertilizers, crop rotation, and irrigation. The former is instanced in the high mountain valleys of Bamina some 200 kilometers west of Kabul; the latter in the valley of Hari-Rud near Herat, where the expedition counted no less than one hundred different crops under cultivation. Of the cultivated area of Afghanistan (about two per cent of the total) at least half (500,000 hectares) is irrigated. At present the irrigated area of Northern Afghanistan is about twice as large as that of Southern Afghanistan, where, however, there is about three times as much potential agricultural land as in Northern Afghanistan.

Professor Vavilov also gives a general survey of the physical conditions of the country, dividing it into six climatic zones. He distinguishes the following nine "agricultural or geographical landscapes": (1) Undulating steppes of the foothills of Northern Afghanistan, (2) the valley of Hari-Rud, (3) the southern deserts of Afghanistan, (4) the Oasis of Kandahar, (5) mountain valleys from 1400 to 2600 meters, (6) the lowlands of Jalabad, (7) high mountain landscape above 2600 meters, (8) landscape of Kafiristan (forest zone), (9) thin stand of juniper and pistachio trees.

The Lumber Industry of Southern Manchuria. Bean and grain fields, coal and iron mines do not tell the tale of Manchuria's riches: there are her forested mountains. According to the latest estimate forests cover 45,000,000 acres, or one-fifth of the total area of the Three Eastern Provinces, a proportion similar to that for the United States. The major forest regions are found in the Great and Little Khingan ranges in the north (Heilungkiang), the Ch'ang Pai Shan in the center (Kirin), and the Yalu River basin in the south (Fengtien). These areas are estimated to contain about 116 billion cubic feet of lumber, and some 26 billion feet may be added for other little-known districts in the three provinces ("Lumber Industry on the Yalu River," *Chinese Econ. Journ.*, Vol. 4, 1929, pp. 522–533). The bulk of the lumber from eastern Manchuria is transported on the Sungari and Yalu rivers, thus dividing the country into northern and southern zones with Changchun, the joint terminal of the South Manchurian and the Chinese Eastern railways, as a common point.

Exploitation of the Manchurian forests on a large scale commenced with the organization of a Russian company to work the timber lands on both banks of the Yalu at the beginning of the present century. Incidentally it was one of the contributing causes to the Russo-Japanese War. At the conclusion of the war the Japanese government took over the regulation of the lumber trade on the Yalu. Forestry on the Korean side became a public enterprise of the office of the Governor-General of Chosen; exploitation of the Manchurian side passed under the control of a Japanese-Chinese concern. Between the two régimes there is now a marked difference. On the Korean side the industry is carefully regulated; on the Manchurian side "no system of afforestation and deforestation has yet been worked out. . . . Deforested areas are now lying waste, and if no forestry law is enacted the rich timber territory may some day become entirely non-productive." Lumbering in the Manchurian-Yalu region is a mixture of old and modern methods. For getting out the logs, for instance, in a few places light railways have been constructed; in other places they are dragged out by cattle. From the river banks the logs are rafted downstream to the headquarters of the company at Antung, between May and December as many as 20,000 of these "strikingly fashioned" rafts coming down the Yalu (compare Adachi Kinnosuke: Manchuria: A Survey, New York, 1925). Thence distribution is made to the cities of Korea, Fengtien, the Gulf of Pechili, and as far afield as Shanghai, Hankow, and the Yangtze cities. Recently, however, there has been a decline in the timber trade of the Yalu, largely through the concurrence of cheaper timber from the great forests of northern Manchuria.

AUSTRALASIA AND OCEANIA

The Morioris of the Chatham Islands. Although there were believed to have been about 1600 Morioris inhabiting the Chatham Islands when these islands were discovered by Broughton in 1790, H. D. Skinner who visited the group in 1920 found only two. (The Morioris of Chatham Islands, *Memoirs Bishop Museum*, Honolulu, Vol. 9, No. 1, 1923). He ascribed this virtual extermination of a race to a number of contributing causes: the introduction of European epidemic diseases, the increasing scarcity of whales and seals from which food and clothing were obtained, and the Maori invasion of 1835 when the Morioris were virtually enslaved. At present, the 450 odd people of a dozen mixed nationalities who inhabit the islands make a livelihood by raising sheep and cattle. The northern half of Pitt Island is cleared of bush and comprises one cattle ranch.

The origin of the Morioris is obscure. H. D. Skinner continued his studies of the problem as a member of the Otago Institute Expedition of 1924 and concluded that they are a Maori offshoot which probably migrated from New Zealand before their textile technique was developed, at about 1350 (*Memoirs Bishop Museum*, Vol. 9, No. 5, 1928). New Zealand, which lacked certain elements of Polynesian culture, thus acted as a stepping stone for these early Polynesian migrants who found the Chatham Islands lacking in the major elements of Polynesian food supply —breadfruit, coconuts, and the sweet potato. Consequently, the Moriori hunted the seal and whale until the destruction of these animals by Europeans contributed to their extermination.

To this day the Chatham Islands, which became part of the Dominion of New Zealand in 1842, are an isolated and little-known group. The islands, which lie some 536 miles east of Lyttleton, comprise Chatham Island (Rekohua) and a group of small islands to the southeast, of which Pitt Island is the largest. Information on the physical features of the Chatham Islands has been summarized by R. S. Allan (*Trans. and Proc. New Zealand Inst.*, Vol. 59, 1928, pp. 824–839). Te Whanga Lagoon in the central part of Chatham Island covers 46,000 acres of the total extent of 222,000 acres. To the north of Te Whanga Lagoon are two connected peninsulas with low-lying mature slopes, the western one showing signs of volcanic activity. The southern part of the island, which rises to nearly 1000 feet along the south coast, is a compact highly dissected remnant of a plateau area. The original bush covering of the islands is extremely dense and contains no large timber. A superficial covering of peat overlies the whole island.

POLAR REGIONS

Nobile's Flights in the Arctic on the Airship "Italia," May, 1928. The unfortunate disaster to the airship *Italia* at the end of the Nobile Arctic flights, May, 1928, the loss of part of its crew, and the rescue of the survivors were matters of such dramatic interest tinged with controversy that they have obscured the real achievements of those flights. It is only now when a number of authentic narratives have appeared, especially an article on the geographical results of the expedition by General Nobile himself ("Die geographischen Ergebnisse der Polarexpeditionen der 'Norge' und der 'Italia,' *Petermanns Mitt.*, Vol. 75, 1929, pp. 189–192) that it is possible to present a connected picture of the flights. This has been much facilitated by General Nobile's courtesy in sending to the American Geographical Society two maps showing the route of the north pole flight and the flight to Northern Land and the areas seen on those flights.

After an initial flight from Kings Bay on May 11, on which it was not possible to proceed beyond North Cape, the *Italia* left on May 15 on the flight to Northern Land. The outward route led eastward along the northern border of the Spitsbergen and Franz Josef Land archipelagoes to a maximum easting in latitude 79° 16′ N. and longitude 91° 40′ E. The return route led thence southwest to the northern end of Novaya Zemlya and thence west-northwest back to Spitsbergen, where Kings Bay was reached on May 18. Between Spitsbergen and Franz Josef Land the reputed position of Gillis Land in 81° 40′ N. and 37° 5′ E. was flown over and no land seen in this vicinity. Parenthetically it may be observed that the land of this name which Captain Gillis reported to have seen in 1707 is probably identical with Gillis Island (also spelled Gilles and Giles) which rises from the submarine ridge connecting the two archipelagoes and whose true position in 80° 3′ N. and 31° 30′ E. was determined by Commander F. A. Worsley in 1925. Even current hydrographic charts, however, showed Gillis Land in the position in which it was sought by Nobile.

Between Franz Josef Land and Northern Land in about latitude 80° and longitude 84° 30′ E. an area of open water extending northwest and southeast, varying from 10 to 40 kilometers in width, was encountered. As the wind was from the north and northeast it was inferred that this open water might indicate the presence of land in whose lee it would then be lying. This locality lies to the east of the drift of the *St. Anna* in 1913–1914 and would agree well with Wiese's deduction of the probability

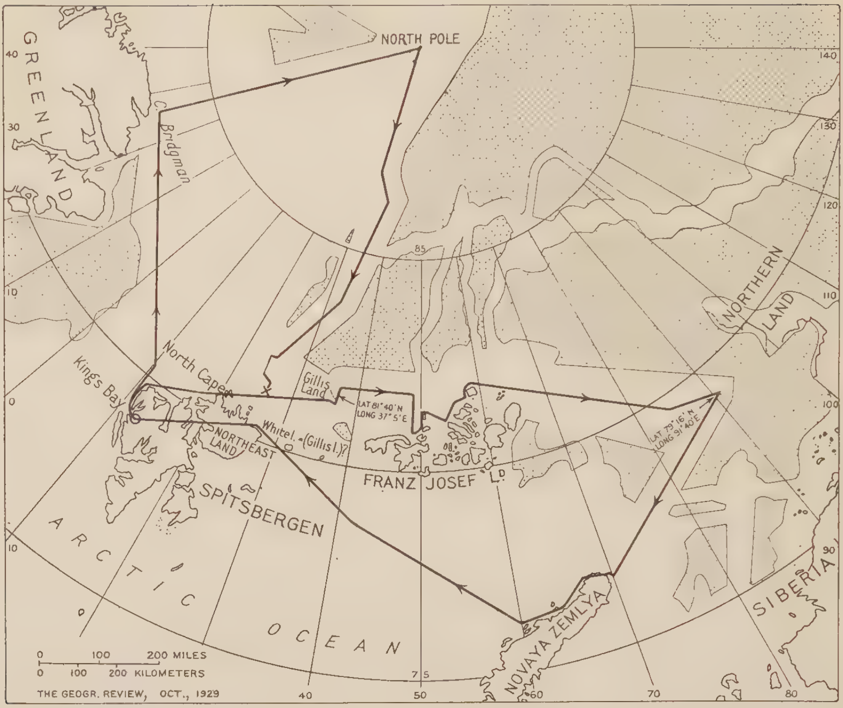

FIG. 1—Map showing routes of the *Italia* on the Northern Land and north pole flights, May, 1928. Scale 1: 20,000,000.

Areas unexplored or not seen are shown in stipple. The routes of the *Italia* and the estimated areas seen along her path are based on manuscript maps sent to the American Geographical Society by General Nobile.

of land in this vicinity on the basis of that drift (*Ergänzungsheft No. 188 zu Petermanns Mitt.*, 1925, pp. 57–58 and Pl. 2, Fig. 4). The flight continued thence for a little less than 100 miles to the most easterly point, but weather conditions unfortunately made it impossible to establish the desired relationship to the known eastern coast of Northern Land. The problem of the western limit of Northern Land therefore still remains unsolved, although Nobile himself believes it probable that the area is an archipelago of which the conjectured land to the windward of the open water area may have been a western member. On this flight Nobile estimates that about 48,000 square kilometers of heretofore unseen territory were seen. These are indicated on the accompanying map.

The flight to the pole took place on May 23, the pole being reached between midnight and 1 a. m., May 24. As it was unfortunately not possible to carry out the original intention of landing there to take a sounding and make other observations, we are still uninformed as to the exact depth of the deep basin of the Arctic Sea at this point and are still dependent on Peary's no-bottom sounding of 2743 meters. The main geographical result of this flight was the crossing, on the leg between Spitsbergen and Cape Bridgman, of the unexplored area off the northeastern corner of Greenland. The leg of the flight from Cape Bridgman to the pole cut a swath similar to Peary's of 1909, only of course wider, through the unexplored area north of Greenland. The newly opened-up patches, including those on the return voyage from the pole, are estimated by Nobile to aggregate 73,000 square kilometers. These flights only revealed Arctic pack and no land.

The catastrophe of the *Italia* took place, according to Nobile, at a point in latitude 81° 15′ N. and longitude 25° 20′ E. When picked up by the Russian ice-breaker *Krasin*, the survivors were about in 80° 50′ N. and 29° E. (see map at back of "The Tragedy of the Italia," by Davide Giudici, special correspondent of the *Corriere della Sera* on board the *Krasin*, New York, 1929). The best account so far published of the flight and the catastrophe is by the Czech physicist, Francis Běhounek (German edition, "Sieben Wochen auf der Eisscholle: Der Untergang der Nobile-Expedition," Leipzig, 1929). Other popular accounts of the rescue have been published by Maurice Parijanine, Russian correspondent on the *Krasin*, "The Krassin," New York, 1929, and by Captain Einar Lundborg of the Swedish air force (English edition, "The Arctic Rescue: How Nobile Was Saved," New York, 1929). Dr. Leonid Breitfuss of Berlin has attempted a critical evaluation of the flights, "Die Nobile-Nordpolexpedition mit dem Luftschiff: Verlauf der 'Norge'- und 'Italia'-Fahrten—Die Rettungsaktion—Die daraus zu ziehenden Lehren," (*Petermanns Mitt.*, Vol. 75, 1929, pp. 1–7 and 71–76). N. Evgenov gives a scientific account (in Russian) of the cruise of the ice-breaker *Sedov* south and west of Franz Josef Land in 1928 to search for the group that drifted away with airship after the catastrophe in *Morskoi Sbornik*, No. 2, 1929, pp. 43–54. It is accompanied by a map showing the different forms of ice met with en route.

WORLD AS A WHOLE AND LARGER PARTS

Aviation and the British Empire. "The advent of the air weapon has lost us our age-long security as an island nation, and has left the greatest city in the world more open to the dangers of air attack than any of the other capitals of Europe." These words of Sir Philip Sassoon, Under Secretary of State for Air (Great Britain), supply the argument of a striking paper, "The Influence of Aviation on International Affairs," by Brigadier-General P. R. C. Groves in the July number of the *Journal of the Royal Institute of International Affairs.* Great Britain is a small country well served with other means of transportation, and in the last few years she has failed to keep pace with the progress of aerial communications. General Groves quotes figures of commercial aircraft mileage for 1926 and 1928 respectively as follows: Great Britain (including the Cairo-Basra Service) 840,000; 950,000: Germany 3,816,000; 6,750,000: France 3,244,000; 4,500,000: United States 4,598,000; 10,472,000. However, the outlook for imperial air communications, at any rate, is now brighter. The line to India is in regular operation, and the opening of the Cairo-Cape Town line is in prospect.

The line to India was officially opened in the latter part of 1928 by Sir Philip Sassoon, who describes the journey there and back in "The Third Route" (Heinemann, London, 1929). The third route, it may be explained, is the way to India by air, succeeding the route via the Suez Canal which in its turn had succeeded the route round the Cape. Sir Philip's narration should contribute no little towards popularizing the route and its vehicle, for the journey as he pictures it is a series of enchantments. But "The Third Route" is more than a delightful travel story: it conveys an idea of "the vital rôle which air power is destined to play in the communications of the Empire." Sir Philip thus confirms the expression of his predecessor along the road in 1926, Sir Samuel Hoare, who in another delightful narrative, "India by Air" (1927) sees the airplane and airship "eliminating the time and distance that are now the most formidable obstacles in the way of Imperial unity."

Both authors dwell on the notable economy achieved by the Middle East Command of the R. A. F. in the defense and policing of the desert stretches between Egypt and 'Iraq. The problem is as old as civilization. The demand it made on the Romans, for instance, is revealed by the extent of their defensive works on the Transjordan border, so clearly visible from the air. Another classic area of conflict between settled and unsettled populations is the North-West Frontier of India. To maintain that frontier on the ground has become increasingly expensive, especially since the World War introduced to the tribes modern tactics and modern weapons. "During the last twenty years of the past century the actual cost of campaigns along the frontier amounted to some £300,000. In the first twenty years of the present century the financial cost mounted to nearly £20,000,000." The airplane offers a cheap and efficient alternative method to the campaign on the ground. One instance of its efficiency is afforded by the successful evacuation of the Europeans from Kabul over the snow-filled passes in February of this year. Another striking example of possibilities of quick action—imperative in dealing with tribal disturbances—is given by Wing-Commander A. A. Walser (Flying on the North-West Frontier of India, *Journ. Central Asian Soc.*, Vol. 16, 1929, pp. 289–297). Where he spent five days, traveling from Peshawar to Chitral "going double marches on a hot and dusty road" he made the return by air in two hours!

Sir Philip compares these two problem areas thus: "Iraq, Transjordan and other Middle Eastern territories strike one as obvious countries for control by air power; because of their level, open spaces, their cloudless skies, and, generally, the favourable conditions for flying that prevail there during most of the year. Here [North-West Frontier] flying seems natural for a very different reason; because the whole face of the land is so broken and heaped up, the valleys so deep and the mountains so high, that only on wings can one move about without infinite toil and labour. It is not good country for flying; but yet country in which flying is the ideal means of locomotion."

The value of airways in Empire settlement as well as Empire defense is also touched upon by General Groves. He instances the development that has resulted from the Perth-Derby air service in Western Australia. The service covers 1400 miles in 2½ days against 13 days by steamer. From the scattered centers along the seaboard families have migrated to distances of a hundred miles and more. Roads and motor roads will follow, and eventually the railway; but here the airway is the pioneer.

General Groves, however, does not mention Canada, whose progress in aviation is truly spectacular. From the Report on Civil Aviation for 1928 (Dominion of Canada, Dept. of National Defence, 1929) we learn that the total of aircraft mileage in the Dominion increased from 393,000 in 1926 to 2,728,000 in 1928. The Western Canada Airways company alone carried nearly 10,000 passengers, over a million pounds of goods, and over 122,000 pieces of mail and flew over half a million miles last year. Their operations included the maintenance of a weekly winter service down the Mackenzie from Waterways to Fort Simpson. But mileage and passengers and freight are not all the story. One of the most impressive features of aviation in Canada is the varied use to which it has been put in the conservation and development of natural resources.

MATHEMATICAL GEOGRAPHY

Recent Developments in Map Projections. There has recently been a distinct revival in general interest in the subject of map projections, particularly of those purporting to show the whole sphere. The merest novice knows that the perfect map is impossible, and yet almost every one with a constructive mind who has touched even ever so lightly on the surface of the technical field of map projections has bethought himself of a "new" map projection. In view of this it seems important that there should be a clear definition as to what is meant by a *new* map projection. It seems also appropriate to point out the widely divergent ideas held by those who are actively engaged in trying to improve the graphical representation of a spherical surface on a flat piece of paper as to what constitutes a *good* map projection.

The mathematician requires a projection having clearly defined properties which can be expressed rigorously. To him the number of individual projections is comparatively few, and most of the map projections are classified by him as variations of one or other of these basic types. His interest is often purely in the elegance of the mathematical conception rather than in the practical application. On the other hand the educator is generally content with a good pictorial representation more or less suitable for all purposes and in his ignorance of the theory will often acclaim as a good general map one such as Mercator's which is misleading in almost every respect if its properties are not understood. It is the professional geographer who takes the middle course. He realizes that there is probably a best map for illustrating any particular set of conditions. Sometimes he requires the property of equal area, sometimes the property of orthomorphism. Sometimes he wishes his map centered at a particular place on the earth's surface. His needs are many and various, and he abhors the limitation or standardization of his map resources.

Nevertheless, many map projection enthusiasts concentrate in attempting to obtain an improved general map of the world for the purposes of showing distributions, etc. Most people agree that the property of equal area is an essential to such a map, but there agreement stops. Some object to curved meridians or parallels, others prefer these to great shape or scale distortion at the extremities of the map. Some will interrupt the surface of the sphere in many places in order to maintain shape, often needlessly sacrificing continuity. Others make a fetish of continuity at the expense of shape.

At present there are three kinds of "new" map projections. The first is "new" because the sphere has been interrupted in a new manner. The second is "new" because the center of the projection is taken to represent a geographical position heretofore not employed, or the original projection has been extended, as for instance, in the case of the hemisphere extended to include the whole surface of the earth. And the third is new because it involves a new mathematical conception or geometrical construction to define it.

Of these three only the last is truly a new projection. The second often requires additional formulae or geometrical construction to develop it from the basic projection, but the first is merely a convenient arrangement of an old projection. It would seem most desirable that these three types of "new" map projections should be differentiated. This would be simple. The first could be called a new arrangement of the given projection; the second a new development of the projection; and the third a new projection.

It is not meant to imply that a new arrangement of an old projection cannot be as useful an achievement as a brand-new projection. Quite the reverse is often the case. A new projection may have no really practical application, while a new arrangement or development of an old discarded projection may be of great consequence. Nevertheless, the advent of a new projection having new qualities or qualities better in some respects than any other projection indicates an important achievement; and it is only right that those whose endeavors lead them towards investigating arrangements of old projections, however useful these may be, should acknowledge the distinction by properly describing their own work.

Two interesting new projections are, first, the conformal projection of the sphere within a square by Oscar S. Adams (*U. S. Coast and Geodetic Survey Special Publ. No. 153, Dept. of Commerce*, 1929), and, secondly, Mr. A. R. Hinks's retro-azimuthal projection of the world ("New Map Projections," a series of papers in Vol. 63, *Geogr. Journ.*, pp. 241–253). The first is definitely a mathematician's map projection and is not likely to be used much if ever in practice by geographers. The second, although it serves its purpose and is thus justifiable, has the distinction of being a projection of the sphere (the word projection here is used, as in the rest of this note, in its broadest sense) on which it is impossible to draw a recognizable map.

Mr. S. W. Boggs's new equal-area projection is likely to be of considerable use in a practical way as it is approximately a mean between the sinusoidal and the Mollweide projections (see *Geogr. Journ.* as before; also *U. S. Coast and Geodetic Survey Special Publ. No. 60*, revised to May 1, 1928; Elements of Map Projections, by C. H. Deetz and Oscar S. Adams).

Recent developments of the Mollweide equal-area projection are to be found in *Ordnance Survey Professional Papers No. 11* (*N. S.*), 1927, "The Transverse Mollweide," by Colonel Sir Charles Close. The latter has more recently developed a general formula for the oblique Mollweide. Examples of developments of the Mollweide have recently been drawn. In the autumn, 1928, issue of *Geography* there is an example by Mr. J. Fairgrieve, and the staff of the School of Surveying of the American Geographical Society have constructed one from independent computations. The latter differs from the conventional Mollweide only in that it has been tilted so that the center of the projection is at 20° North. An example of the oblique Mollweide also appears in Harmsworth's "New Atlas of the World," page 484.

Professor J. Paul Goode continues to investigate useful new arrangements, and the University of Chicago Press has recently published an addition to Goode's Series of Base Maps and Graphs. This is entitled "Goode's Polar, Equal Area Projection for the Continents" and is an admirable arrangement of Werner's equal-area projection in that it shows the relationship between the north pole and the land masses with very little distortion. There is an insert map of the south polar regions on Lambert's azimuthal equal-area projection. In the discussion following a paper entitled "A New Map for Meteorologists," by B. J. S. Cahill, in which the author advocates the use of his patented map for world weather information, comparisons were made between the latter and Professor Goode's new map (see extract of paper in *Bull. Amer. Meteorol. Soc.*, March, 1929, Vol. 10, pp. 66–67. Mr. Cahill's and Professor Goode's papers have been published in the *Monthly Weather Rev.* for April, 1929).

Before concluding this note mention should be made of Mr. E. A. Reeves' new device for obtaining by means of a diagram, without computation, the true bearing between two points on the earth's surface, and finding the latitude and longitude of points on the arc of a great circle between two stations (*Royal Geogr. Soc. Technical Ser. No. 5*, 1929). This admirable invention is avowedly not a new map projection. It is based on a conventional geometrical projection. Its uses are many, one of the most important being that it enables one to plot great circle courses on any kind of small scale map projection without computation.

PHYSICAL GEOGRAPHY

Dunes and Their Relation to Climatic Studies. At Repetek, about midway on the railroad between Merv and Bukhara, the Russian government maintained a meteorological station from 1913 to 1918 and revived it again in 1926–1927. In the second period botanical and other studies have also been carried on, and here Arved Schultz made his headquarters for a detailed study of the dunes (Morphologische Beobachtungen in der östlichen Kara-kum-Wüste (Turkestan) 1927, *Zeitschr. für Geomorphologie*, Vol. 3, 1928, pp. 249–294).

The climate of Repetek is truly arid with a mean precipitation for the years 1913–1917 of 94 millimeters (3.7 inches). The summer is rainless, except for rare storms such as occurred in June, 1926, and has an air temperature reaching up to 50° C. (122° F.), while the sands become heated to 80° C.

The region of Repetek consists of great belts of dunes 5 to 20 kilometers long separated by sandy flats or "valleys" 1 to 7 kilometers broad. The flats are apparently remnants of an ancient drainage system. The belts of dunes have a steep slope 30 to 65 feet above one "valley" and a transition into the other. The sandy hummocks of the "valleys" are formed around the vegetation, which is almost wholly dependent on the water table. In the lower parts of the "valleys" water lies about 11 feet below the surface and in the higher parts more than 24 feet below.

The dunes are almost completely reversed each year, as the strong south winds of winter undo the work of the more continuous but lighter north winds of summer. In spite of this complete change in slopes the dune ridges and dune masses consist of barchan-like forms, although only about five per cent of the dunes are true barchans. The true barchans consist of subtypes: (1) the normal barchan, (2) the reversed barchan, (3) the disarranged barchan of four kinds (twin barchans by junction of neighbors and by overriding of one over another; longitudinal and transverse sickle-like mounds), (4) the cross barchan, (5) the sand mound, (6) the sand ridge, (7) the sand heap. The shapeless forms of 5, 6, and 7 are regarded as degenerate or incipient barchans. The cross barchans are small barchans that lie at the foot of the steep slope of larger forms and are due to a cross wind sweeping around the end of one wing of the barchan.

Clayey banks, sand heaps around bushes, and other minor features characterize the depressions between dunes. The fact that the material between dunes and in the valleys is generally finer and, in places, compacted by clay and by plant roots is cited to show that a firm base is necessary for the formation of barchans. A supply of sand and wind would produce only irregular heaps and wind ripples. This conclusion seems to be only partially true, as their critical factor is the supply of sand. If too much is furnished, irregular dune areas of longitudinal or transverse type result; whereas a moderate supply of sand produces barchans. Obviously the existence of a firm base prohibits the pick-up of new sand and thus regulates the supply. Also the base must not be too damp or have too heavy a vegetative cover, or the movement of the sand is hindered and the true barchan cannot develop.

Schultz's attempt to place the forms of the sand in this area in a developmental series which can be used as an indicator of past climate is not comparable in value to his observations on barchans. We may be sure on other evidence that the dune areas of the Kara-kum developed under a fluctuating climate, but his correlations appear premature.

The value of dune studies of this type is very great. The literature on dunes is enormous, and yet many problems are far from solution. Thus Herbert Louis (Die Form der norddeutschen Bogendünen, *Zeitschr. für Geomorphologie*, Vol. 4, 1929, pp. 7–18) presents a new study of the much studied North German dunes. These bow-shaped dunes with the curve of the bow to the east have a superficial resemblance to barchans, but the steep slope lies on the outside of the bow; and, as revealed by road cuts, the internal structure shows that the lee side is to the east. They must have been formed by westerly winds. But, as the south wing of the crescentric ridges has almost equal slopes, Louis holds that the dunes were modified by southwesterly winds. As the dunes are now fixed in position by forests they furnish a record of the wind system of the past. A west wind during the retreat of the Würm (Wisconsin) ice may have formed the dunes and have been followed by southwesterly winds of the present time. Thus Louis rejects the interpretation of Solger and follows Högbom and Hörner in their interpretation of the Swedish dune areas. The arguments of these authors that the bow-shaped dunes of Sweden and Germany should be interpreted as being formed by a wind blowing in the direction of the arrow in the bow must obviously be accepted. Nevertheless the conditions that lead to the formation of dunes of this shape are not yet known. In all deserts today barchans whose wings point in the direction of the wind are normal forms. Even on the famous Kurische Nehrung the dry sand moving over the underlying damp sand will, with a steady wind of one or two days' duration, form a barchan 25 feet high (F. M. Exner: Über Dünen und Sandwellen, *Geogr. Annaler*, Vol. 9, 1927, pp. 81–99). Obviously some special condition must have existed in the sand plains left by the retreat of the ice. The further study of dunes may lead to an explanation of this special condition. At the same time the development of suitable criteria may make possible such valid interpretations of the wind conditions of the past as to lead to important conclusions not only in areas within the influence of the continental ice sheets but in desert regions. With the development of such criteria arguments as to the succession of past climates as attempted by Schultz will gain greater credence.

Kirk Bryan

HUMAN GEOGRAPHY

Cycles in Metal Production. In a paper of this title Dr. D. F. Hewett of the U. S. Geological Survey presents a series of curves showing the annual production of the principal metals (iron, copper, tin, lead, silver, and mercury) for the outstanding mining districts of Europe and the United States (*Amer. Inst. of Mining and Metallurgical Engineers Tech. Publ. No. 183*, 1929). Analysis of these curves and comparative study of the broader history of the metal industries in Europe lead him to certain significant generalizations. Maximum production has tended to shift during the past 125 years from one country to another. Thus, "districts in Norway, England, and Spain [have been] successively outstanding sources of copper, and in England, Germany, and Spain, of lead." Declines in production from most of the districts and declines in the grades of ore treated have been characteristic of recent years. Within each nation, moreover, each metal industry would seem to pass through a sequence of "life stages." The peak in the curve of exports of crude ore is usually passed early in the history of the industry. As more mines are developed, local smelters and refiners are established; and these absorb the domestic ore, cutting down exports. Under ordinary conditions many small and unprofitable deposits are worked experimentally and abandoned before it becomes "known where the largest and richest bodies of the district lie." It follows, therefore, that the peak in the curve for number of mines is also passed relatively early, before the maximum number of smelters and refiners and the peak in production have been reached. "Finally, with the failure of local sources of ore and the maximum advance in technique, smelters and refiners not only need but attract ore from remote sources, and trade in imported ore naturally begins. Whether and how long metallurgical industries survive depends upon the local fuel and power supplies and the maintenance of competitive technique."

There is also a tendency, well defined in frontier regions but apparent even in Europe, for metal production as a whole to pass through successive epochs: "an age of gold, then of silver, then of copper, then of lead and of zinc, then of iron" (Louis de Launay: Le conquête minérale, Paris, 1908, p. 27, as cited by Hewett, *op. cit.*, p. 28). This order, Dr. Hewett points out, corresponds to "the order of prices [that] has been maintained for several hundred years [and] represents roughly, also, the order of abundance of the metals as shown by production in recent years."

On the whole, the "immediate outlook for an increase in metal production in Europe is not encouraging, iron possibly being excepted." In the United States the district production curves make it clear that "many of our outstanding districts of a few years ago show signs of exhaustion, and [that] we are sustaining or increasing national totals by turning quickly to new sources of lower grade. If science and technique can keep up the pace, we have no cause for concern." Dr. Hewett, however, doubts that they can do so much longer.

The Harris Institute Conference on Population. Population and migration were the subjects discussed at the Sixth Institute of the Norman Wait Harris Memorial Foundation for the Study of International Relations, which was held at the University of Chicago, June 17–28, Professor Quincy Wright acting as chairman.

The outstanding fact developed by the round table discussions was the prospect of a stationary population in northern Europe (excluding the U. S. S. R.) and in the United States within a generation. Indeed, in England and Germany the birth rate has fallen so low that the population will not be maintained after the present generation of young people become old. Unless, therefore, the birth rate reverses the present downward trend, or unless extensive immigration sets in from southern or eastern Europe, it appears inevitable that the population of these two nations, and probably of other nations in northern Europe also, will decline after reaching a maximum 20 to 30 years hence. This fate will overtake the United States also if the birth rate falls much below the present level, unless immigration laws are changed.

The significance of this prospect to the farmers of the United States, to urban property owners, to tenants, indeed, to almost every one, can scarcely be overemphasized. Agricultural production in the United States at present, except of sugar and certain tropical products, is almost sufficient for 150,000,000 people having the present standard of living, and it is probable that there are almost enough houses or apartments in the cities for a population of this size. Since building construction is certain to continue, though probably to a lessening extent, it is likely that the less desirable houses in the cities will depreciate greatly in value in the course of a few decades. Since the less desirable farm lands in the country have been declining in value for years, they will be less affected. Indeed, it is not unlikely, in view of the industrialization and increasing population of Asia, that the value of farm land in the United States may rise slightly as exports increase.

Of course, if the prospect of declining population should prompt the American people to modify their immigration policy, these economic consequences might be avoided and the era of high prices maintained for such products as were not sold on the world's markets. There is no sign yet of appreciable voluntary restriction in population in the U. S. S. R. or the Orient except in Japan, and the higher standard of living in the United States would undoubtedly be very attractive to the people of these countries, as it has been in the past.

The Proceedings of the Conference will be published late in the autumn by the University of Chicago Press.

O. E. Baker

OBITUARY

Émile Chaix. The *Journal de Genève* for May 15 announces the death of Émile Chaix, professor of physical geography at the University of Geneva, at the age of 74. Early in his career Professor Chaix resided in Russia and later acted for a time as secretary to the Swiss legation in Belgrade. Travel in various Russian and Serbian regions and especially close observation of natural phenomena in those "pays tourmentés" of the Dinaric Alps led him to physical geography. His work in this field includes studies of vulcanism in Italy, notably the construction of a fine map of Etna on a scale of 1 : 100,000 (1892); of coast erosion in the Channel Islands; of erosion by running water in alpine valleys; of solifluction; and especially of lapiés. Some of these studies were carried out in conjunction with his son André, with whom he also made investigations in the Swiss National Park in the Engadine. He was a member of the American Geographical Society's Transcontinental Excursion in 1912 and contributed a paper on some geysers of the Yellowstone to the Memorial Volume. The results of his researches, however, are published for the most part in *Le Globe*, the journal of the Geographical Society of Geneva.

Professor Chaix was not only a student but also an admirable teacher. As an ardent believer in the value of illustrative material—photographs and maps—as a means of instruction he advanced the idea of the "Utilité d'un atlas international de l'érosion" (*Le Globe*, Vol. 45, 1905) and, having secured the coöperation of Jean Brunhes, presented his plan before the Ninth International Geographical Congress which met at Geneva in 1908. In somewhat more comprehensive form it materialized as the "Atlas Photographique des Formes du Relief Terrestre" (Album of Landforms), published under the auspices of an international commission by an executive committee consisting of MM. Brunhes, Chaix, and Emm. de Martonne. The first installment appeared in March, 1914, and thereafter the war put a stop to further publication. At the Cairo Congress in 1925 a resolution was passed for resumption of the work under the International Geographical Union.

For many years the Chaix family has played a prominent part in the activities of the Geographical Society of Geneva—Émile, his distinguished father, Paul, and his son, André—"belle dynastie de géographes," as Eugene Pittard says in a sympathetic memorial appearing in the June number of *Der Schweizer Geograph.* Émile Chaix, like his father also, was a Corresponding Member of the American Geographical Society, being elected in 1889.

Hans Meyer. Professor Hans Meyer, well known for his studies in colonial geography, died in Leipzig on July 6, 1929, aged 71 years. His work was essentially directed towards the placing of colonial policy on a sound basis by resting it on a scientific knowledge of the colonial regions and their peoples. His first travels took him round the world in 1881–1882, on which occasion he devoted special attention to the Philippines. In 1886 he began his series of African journeys, of which the crowning event was his conquest of Africa's magnificent mountain Kilimanjaro, described in "Across East African Glaciers: An Account of the First Ascent of Kilimanjaro" (London, 1891). "Der Kilimanjaro" (Berlin, 1900) is the narrative of the fourth expedition and a summarizing of the author's observations on past and present glaciation in East Africa. This subject, the glaciation of high mountains in the equatorial regions, was one of Meyer's particular interests, and he later carried his studies therein to South America ("In den Hoch-Anden von Ecuador," Berlin, 1907).

Dr. Meyer was instrumental in the organization of the Landeskundliche Kommission zur Erforschung der deutschen Schutzgebiete, which prosecuted research in the German colonies, both by the promotion of field studies and the publication of results in its magazine, *Mitteilungen aus den Deutschen Schutzgebieten*, and in a series of monographs. As his own share in this work Meyer published in 1909 the admirable "Das Deutsche Kolonialreich," in five parts, himself contributing the section on "Ostafrika." He is also the author of volumes on "Die Barundi" (Leipzig, 1916) and "Das portugiesische Kolonialreich der Gegenwart" (Berlin, 1918).

A biographical sketch of Dr. Meyer by Karl H. Dietzel appeared in *Geographischer Anzeiger* (Vol. 29, 1928, pp. 73–76), and a bibliography of his writings in "Koloniale Studien" (Berlin, 1928)—a *Festschrift* of interesting papers commemorating his seventieth birthday.

GEOGRAPHICAL REVIEWS

SIBERIA UNDER THE SOVIET RÉGIME

GEORG CLEINOW. **Neu-Sibirien (Sib-krai): Eine Studie zum Aufmarsch der Sowjetmacht in Asien.** xv and 426 pp.; maps, ills. Reimer Hobbing, Berlin, 1928. RM. 30.

It would have been better had the contents of this book been put into two volumes, the first a scientific discussion of Siberia, the second comprising the ideologies of the author. He is less interested in Siberia as nature presents it than he is in what the Soviet authorities may make of it in the way of a self-contained political and economic realm. It is the fate of Siberia to have all of the new problems of a pioneer society on a large scale and at the same time to be taken as a field of experiment by a small group of men (there are only 61,500 communists in a population of 8,000,000) who are trying to reorganize society. The "dictatorship of the proletariat" runs into the difficulty of finding how to make and keep a proletariat in a frontier society where extractive industries are the rule and capital is lacking with which to encourage industry that may serve the double purpose of making a better-balanced economic life and furnishing "members for the party." The outstanding fact in the present economic organization is the regional division of the country, its *rayonierung*, as it is termed, by which means it is hoped to work out a collective economic development on a broad scale under centralized control. Side by side with this plan there is an attempt in Siberia to work out the development of nationalities (of which six principal ones are recognized) so as to provide for what is termed "kulturpolitik" decentralization—the idea of associated republics versus an imperialistic state. At least so far into politics are we obliged to go to understand the political map of Asiatic Russia today.

Among the geographical elements the most important by far are those that relate to pioneer settlement and the way it is being conducted today from the railway base, chiefly the Trans-Siberian Railway and its feeders along the Asiatic extension of the *chernozem* or black-earth belt. There is no one Siberian type of land use; there are types as varied as the land itself and the people. Often each village is a law unto itself because of the variety of places and cultures represented in the population. There are numerous religious sects from various parts of old Russia, as well as Germans, Poles, Letts, Esths, Tatars, Kirghiz, and Kalmucks, in scattered settlements in the west; and there are over 600,000 Mongols in addition to the bulk of the population (with over six million White Russians heading the list) drawn from thousands of Russian villages. Since agriculture at first meant only food for domestic use, and still means that to large degree, it was natural that "the size of the family was and is the measure of the wealth of a Siberian farmer." There is a high percentage of young married couples. There is much coöperation of neighbor with neighbor in seeding and harvesting as well as in the use of machinery, tools, and draft animals, one man contributing a plow, the other a horse. There is a valuable account of the mode of development of the Kusnetsk-Altai region. When the number of farms had grown to the point where all the land about a village was occupied, and every person and domestic animal was economically employed, another village came into being on the margin of the territory occupied by the first. There was difficulty in the grazing of the land wider afield because of lack of capital and danger from wild animals. If labor was required for public works or industrial development it had to be imported, because every man was anchored upon his own land. A message was sent to the home village in Russia and new immigrants were attracted, not by the promise of a wage but by the offer of land which the employer could get through his influence with the government. But the new settler was economically and politically bound to the employer through the device of an advance to him of provisions and tools.

How the squatter operates on the frontier is the theme of one section, and the floating population another, with much comment upon the process by which settlers try to gain independence by going beyond reach of government in many a corner of the remoter steppes and forests. The economic development of the land by close settlement requires railways and highways, and the lack of both produces effects here vividly set forth—the long broad tract (five to ten kilometers wide) over which the carts go in summer, narrowing to a focus at a stream crossing or a swamp or a railway station. Tributary roads come in over the prairie in direct lines, cross-lots, so to speak; and the tendency is carried even further in winter, when streams furnish new if temporary highways and change the pattern of the roads, the whole countryside being under deep snow and transport going any way it pleases. Automobile roads would help transport enormously, says the author, and they would intensify the use of the land even if at first only a limited number of trunk lines could be built.

First in importance in bettering transport and economic development is the improvement of railway communications between the cotton-and-dried-fruit region of locally irrigated Russian Central Asia and the grain-growing region of Western Siberia. Russia requires more and more cotton and cotton goods, and the Siberian and Turkestan region can largely supply them. The author sees the great advantages of a textile industry created in the area of cotton production not merely for the good of the region but also to supply the growing need for textiles in Mongolia and western China, of whose political importance to Russia he has much to say. This would have the effect of reducing transport costs on cereals to feed the cotton districts and would lead to a largely self-contained Central-Asian economic unit. The trade outlets and conditions are analyzed, the Ob and the Yenisei and the Kara Sea route and the difficulties of shipping out the raw products of an extractive economy to distant European markets. The chief trade needs of China's outer territories in Asia being manufactured wares, Russia is in no position to supply them, but she may compete in textiles ultimately. The dairy business is especially emphasized, for it may be increased to supply the capital needed for other than purely agricultural purposes. Statistics are given, and some analyses of them, for the export and import trade, its trends, and the forms of production that can most readily be increased under present conditions.

Altogether this is the leading book on Siberia, as it claims to be; which makes it a pity that the maps are not more than rough sketches, that the number should not have been greatly increased to enable the reader to follow the detailed text, and that the absence of an index requires each reader to construct his own if he wishes to consult this highly useful volume again.

LATTIMORE AND SVEN HEDIN IN THE GOBI

OWEN LATTIMORE. **The Desert Road to Turkestan.** xiv and 331 pp.; maps, ills., index. Methuen & Co. Ltd., London, 1928.

SVEN HEDIN. **Auf grosser Fahrt: Meine Expedition mit Schweden, Deutschen und Chinesen durch die Wüste Gobi 1927–28.** xii and 347 pp.; map, ills., index. F. A. Brockhaus, Leipzig, 1929.

The routes across the heart of the Gobi followed in 1926–1927 by Lattimore and a year later by Sven Hedin were approximately the same. Both travelers journeyed from Peking to the Mongolian frontier by rail; both struck directly over the Alashan

Desert to the strange river Edsin Gol, which loses itself in two salt lakes; and thence over the Black Gobi to Chinese Turkestan. Lattimore tells us that this route is known as the "Winding Road" and that of late years the Chinese trade caravans have been following it rather than the old, established routes farther north. By taking this difficult passage they keep as far as possible to the north of "Chinese officials collecting *likin* or transit taxes" and far enough to the south of the independent Mongol tribes to avoid confiscation of their goods. The latter evil may be attributed to Soviet influence, which is attempting "to bind Mongolia economically to Russia" by enforcing "a prohibitive discrimination against Chinese trade." Although parts of the territory traversed by the "Winding Road" had been visited by other explorers, Lattimore claims to have been the first "to follow it throughout with a conscious interest in its history and its relation to the other great highways of inner Asia."

The latter portions of the journeys of Lattimore and Sven Hedin were made in the late autumn and winter. Both travelers had to contend against the hardships and dangers of the fierce mid-Asiatic winter, and both encountered suspicion and active opposition from the local authorities when Chinese Turkestan was finally reached. Lattimore was detained for several days in the miserable town of San-t'ang Hu, and at one time it looked very much as if the entire program of the Sven Hedin expedition would fail owing to the hostility of Yang Tsen Hsin, at that time the powerful governor of Sinkiang (Chinese Turkestan). Yang, however (about whom Hedin gives some interesting details), was finally won over and did all he could to promote the success of the expedition. But at best the complicated cross currents of political intrigue engendered by the Chinese and Russian revolutions have raised difficulties for the present-day explorer in Mongolia and Central Asia that were unknown before 1911.

Although the routes followed and the troubles encountered were similar, two more unlike journeys could hardly be imagined, nor two more unlike books recording the results. Lattimore traveled alone with a trusted Chinese servant and a few hired camels and their attendants, sometimes joining a commercial caravan for a longer or shorter stretch. His purpose was "to break with the office life of the fringing coastal ports, to go somewhere a long way off, to countries where men do things as they were done uncounted years ago, because their fathers did things in that way." Elsewhere he writes: "Those were high days for dreaming, before the cold began and the really arduous marches. Part of the magic of Mongolia is in the satisfying physical joy of immersion in the life of monotonous fatigue and simple laziness; the shifting landscapes, the feeling of bodily exaltation in the proud distances and swinging marches. Part of it is in learning the tone and spirit of men whose crude but tradition-informed manners and society are only a rough balancing of physical needs; in long idle talking not made brittle and false by thought, and in longer, idler silences."

Knowledge of their language and a sympathetic spirit of understanding gained for Lattimore the confidence of "camel pullers," desert rovers, bandits, and village folk, who seemed to forget that he was a foreigner and would talk freely and naturally with him. His was not a "scientific" expedition, in that he did not attempt to make precise, quantitative measurements. He used no calipers on Mongol crania and no theodolite or plane table on the Mongolian landscape. Some of the time he did not know exactly where he was, and it would be difficult to plot his route on a large-scale map. The poetic, subjective note struck in many passages throughout his book, however, lends it an unusual charm, and the curious and obscure facts recorded about the lives and traditions of the people of the Gobi are of rare value and interest. We learn, for instance, of the great trading firm of Ta Sheng K'uei with headquarters in Kuei-hua, which "has been established for more than two hundred years; it has a history that would stand well beside that of the Hudson's Bay Company." Lattimore has little sympathy for the Chinese policy of agricultural settlement in Mongolia. "The Chinese are evicting the Mongols, as near as I can compute, at about the rate of 10 miles a year, all along the edge of the red and blue and gold and purple Back Country, behind the Ta Ch'ing Shan," but the movement will not solve the problem of overpopulation. "This vice in Chinese political economy might be corrected by saner marriage customs; certainly never by merely expanding the area of their breeding-grounds and burial-grounds."

Sven Hedin's party consisted of eighteen white men, ten Chinese, thirty-four servants, and, at one time, 392 camels. The European staff consisted of Swedes, Germans, and a Dane; it included a geologist; a physician who took anthropological measurements on the side; an archeologist; three meteorologists; a "navigating officer" who operated the wireless receiving set; a moving-picture man; a treasurer; several people in charge of the supply train, as well as general utility men. The Chinese staff comprised specialists in archeology and meteorology, together with five students. A vast quantity of impedimenta was taken along, including a library of Chinese historical works bearing upon the regions visited. The expedition was normally divided into three columns which swept the country over a broad front; triangulation nets were established, topography was sketched on the plane table, special geological and archeological maps were made, meteorological observations taken, and sounding balloons sent up daily. During prolonged halts special parties were sent out to visit neighboring localities. Never has a more elaborate and comprehensive exploring expedition penetrated the heart of Asia. The government at Peking had at first offered opposition, but finally the matter was adjusted by arranging to have the Chinese scholars take part in the work, with what appear to have been admirable results, for Sven Hedin gives a glowing account of the harmony that at all times prevailed. The primary purposes of the Chinese members were the making of archeological and meteorological observations and the establishment of five permanent stations in central Asia to coöperate with the observatories in China in the preparation of weather forecasts.

Sven Hedin sent his book to the publisher in August, 1928, during a brief sojourn in Sweden before returning to Chinese Turkestan. Notices in the press indicate that the work of the expedition was continued through last winter and will be carried on over one or two years more.

"Auf Grosser Fahrt" is a lively and vigorous narrative of the first year's experiences written for the general public. It tells us a great deal about the conduct and daily life of the expedition and the difficulties encountered and also something of peoples seen and country traversed. The scientific results of the expedition when finally published should be very impressive and should go far toward removing those last traces of the glamor of the unknown that still lingered over the Gobi when Lattimore made his way across it.

Problems of the Pacific

J. B. Condliffe, edit. **Problems of the Pacific: Proceedings of the Second Conference of the Institute of Pacific Relations, Honolulu, Hawaii, July 15 to 29, 1927.** xiii and 630 pp.; maps, diagrs., index. Univ. of Chicago Press, Chicago, 1928. $3.00. 9½ x 6½ inches.

No geographer who deals with the Pacific area can afford to be without a working knowledge of this book. He would do well to begin with a chapter near the end entitled "The Human Potential in Pacific Politics" by Herbert Croly. There he will find the case of disinterested research set forth with a breadth and penetration altogether unusual, which stamps this paper as the leading contribution of the book. Croly describes the object of the Institute of Pacific Relations as an attempt "to give reality to the vision of the Pacific as an area of positive political association among the inhabitants of its shores, . . . " He goes on to say that its purpose is to inquire, study, and consult in order to be aware of the processes of life among the Pacific peoples and believes that because of such comprehension, creative work will be done. Anyone who reads page 585 in Croly's paper (dealing with the problem of surplus population in Japan) and then turns to the most important scientific paper in the volume, that by Dr. Shiroshi Nasu on "The Problem of Population and Food Supply in Japan," will find himself almost in a new world of understanding. The views of these two writers are in opposition, and yet each view is so temperately and reasonably expressed as to make it possible to continue the discussion in later conferences, and thus see what approach to agreement may be made. Nasu points to the effort that Japan is making to solve the problem of surplus population and how restricted will be the benefits of even the most intense application of science to the problem on the Japanese homeland. He asks a more just international relationship for Japan in the light of these desperate efforts and Japan's ever more desperate condition. By contrast Croly can see no relief through the export of population or manufactures to other countries in larger measure unless the Japanese themselves try persistently and intelligently to reduce the volume of their surplus population. He can see "no stable international pacification unless the progressive societies set up an intelligent censorship over the increase of population."

The other papers in the volume might be said to revolve in an orbit with two foci, one set up by Croly and the other by Nasu. After reading their arguments, one turns with heightened intensity of interest to the meaning of the technical papers that comprise the greater part of the volume. Special mention should be made of the well-organized and intelligent papers by Baker on "Land Utilization in China" and "The Progress of Population," of Alsberg's "The Factors That Govern Population Growth," and of a great variety of papers from specific standpoints, namely those on the population of the Philippines, New Zealand, Korea, Australia, China, and Japan. While the papers are unequal in value and some of them vague and confused in their geographical or economic or social implications and arguments, they are all informing, all worth while. All of them are prompted by the spirit of inquiry and accommodation rather than that of propaganda or special pleading. The volume is a new point of departure in critical studies in the Pacific area, whether these lie in the field of geography or economics or statesmanship.

Contributions to Mexican Geography

Maximilien Sorre. **Mexique; Amérique centrale.** 234 pp.; maps, diagrs., ills., bibliogr., index. (Géographie Universelle, Vol. 14.) Librairie Armand Colin, Paris, 1928. 60 fr. 11½ x 8 inches.

Ernest Gruening. **Mexico and Its Heritage.** xix and 728 pp.; map, ills., bibliogr., index. Century Co., New York and London, 1928. $6.00. 9 x 6 inches.

Frank Tannenbaum. **The Mexican Agrarian Revolution.** xvi and 543 pp.; maps, diagrs., bibliogr., index. (The Institute of Economics of the Brookings Institution.) The Macmillan Co., New York, 1929. $2.50. 7½ x 5 inches.

The close proximity of the primitive and the modern in a country of sharply contrasting types of environment has created a geographic mosaic too intricate to be explained in a single volume. Only by studying the phases of Mexican life individually and superimposing them on a background of environment can one hope to obtain an adequate understanding of the country. In "Mexique; Amérique centrale," Volume 14 of the admirable "Géographie Universelle" series, Maximilien Sorre has presented a foundation for further investigation in both Mexican and Central American geography. The four sections of the book contain a general introduction to the geology and physical geography of the countries bordering the "American Mediterranean" and more detailed geographic studies of Mexico, Central America, and the Antilles.

About a fourth of the volume is devoted to Mexico. As the author states, "The distribution of the land combined with a geographic condition which renders internal communication difficult, the semidesert character of a large part of the country, an incomplete fusion of races, and arrested development on the part of one faction of the population contribute to explain the unequal and retarded conditions in Mexico. These relationships will be established by a regional study of the country." On a basis of physical geography, climate, and vegetation the country is divided into regions ranging from rainy tropical lowlands to desert plateaus. Limited space precludes the development of other than the major geographical relationships such as types of agriculture, location of railroads, mining, and the position of cities. In no case does the individual Mexican emerge. Political and military geography are omitted, though certain locations like Chihuahua and Sonora, rendered inaccessible because of distance from the capital, and Morelos and Jalisco, difficult of access because of mountainous topography, seem to be perennial centers of revolt. Especially favored positions such as the Laguna cotton-producing district and the port of Vera Cruz are repeatedly foci of attack. But, because of its fundamental character, further development of industry and changing political conditions will detract little from the value of "Mexique; Amérique centrale."

"Mexico and Its Heritage" is not geography. To a large extent it ignores environment. The major social forces of Mexico, such as the church, the army, land systems, labor, and the revolutionary movement, are considered historically and in relation to one another. Conditions in Mexico are like a pendulum swinging from one extreme to the other. The oppressed faction has always merited sympathy, but on attaining power it has resorted to excesses that have alienated this sympathy.

The present political and social conditions of the country are regarded as an outcome of the conflict between the Indian majority and the ruling Spanish minority. "Both nationalities are worse off for their unnatural relationship. That is the Mexican's racial inheritance." The Catholic Church, the Spanish language, and the republican form of government are but a veneer that conceals the Indian character of the nation. Indians now make pilgrimages to worship the Virgin at Guadalupe where, before the advent of the Spaniards, they paid homage to Tonantzin, the goddess of the earth and corn. The Mexican language has been enriched by additions from the Nahautl, and in the remoter sections of the country the Spanish language is still unknown. President Juarez, of the last generation, and General Amaro, the present Secretary of War, are among the exceptions who prove that the Indians are still capable of producing national leaders. In general it is the mestizo who capitalizes his Indian ancestry to gain popularity, and his official position to gratify his personal ambitions. However, it is worth nothing that expenditures for public health have increased sixteenfold since the time of Diaz, rural schools are being opened, and real efforts are being made to develop the talents of the Indian rather than to cast him in the mold of the Spaniard.

The volume is without bias; it is carefully documented and is accompanied by an excellent bibliography and a selection of illustrations representative of Mexican life. Though often ponderous, "Mexico and Its Heritage" does convey the impression of Mexico as a nation composed of separately operating states and dominated by unfortunate social forces whose roots extend back to the time of the Spanish conquest.

With the exception of the thirty-five-year rule of Diaz, Mexico has been in a state of continual revolution since 1810. The revolution against Spain, motivated largely by agrarian ambitions on the part of the Indians, resulted in independence but failed to gratify those ambitions. Effort on the part of Diaz to settle the problem of land boundaries resulted in a more rapid concentration of land, particularly in the hands of foreigners. This was the basis of the revolution of 1910. The situation subsequent to that date has been analyzed by Frank Tannenbaum in the "Agrarian Revolution in Mexico." Article 27 of the Constitution of 1917 defined and limited landownership and furnished a formula for the solution of the land problem, and Article 123 established the rights of the worker. By reason of its concentration in pueblos, the rural population, as well as the industrial population, is able to demand its rights as a group. The operation of these two articles has freed 47 per cent of the agricultural population of Mexico from peonage. Access to the files of the national and state governments in Mexico has enabled Tannenbaum to present an abundance of material never before published in the English language. From the maze of ambiguous data he has extracted valuable information as to the size and value of landholdings in Mexico and the actual amount of land owned by foreigners. The material accomplishments of the National Agrarian Commission have been traced through 1928; but the greater significance of the Mexican Revolution lies in the fact that "Mexico is the first of the Latin-American states in which the mass of the underlying population has achieved access to political dominion in more than a figurative sense."

Problems in the Physical Geography of Palestine

Bailey Willis. **Dead Sea Problem: Rift Valley or Ramp Valley?** Map, diagrs., ills. *Bull. Geol. Soc. of America*, Vol. 39, 1928, pp. 490–542.

Bailey Willis. **Earthquakes in the Holy Land.** Map, diagr., ills. *Bull. Seismol. Soc. of America*, Vol. 18, 1928, pp. 73–103.

On July 11, 1927, much destruction was caused by an earthquake in Palestine. Bailey Willis, in the course of his travels, happened to arrive there the next day, and with great energy threw himself into the study of the causes of the disaster; these papers contain the results of his studies and observations. The first paper discusses the geology of the region and the forces involved; in the second, after giving a list of one hundred and twenty earthquakes, most of them destructive, which have occurred in Palestine and Syria from 1606 B.C. to February, 1928, he describes the effects of the recent shock, their distribution, and the causes of the distribution.

In crossing southern Palestine from west to east, we encounter first a coastal plain ten to fifteen miles broad limited on the east by chalk cliffs. Then comes an arch with gentle slopes rising to a height of 2600 feet, sloping down more steeply to the valley of the Jordan and the Dead Sea, and ending in cliffs opposite the latter. This is the Judean plateau. Opposite on the east, lies the Transjordan plateau which repeats the topography of the Judean plateau in the reverse direction, except that it does not descend to sea level but passes over into the Arabian plateau to the east. Between the two lies the Dead Sea and the valley of the Jordan. The surface of the Dead Sea is 1200 feet below sea level, and its bottom 2600 feet—a mile below the bounding plateaus. The distance between the opposing cliffs bordering the Dead Sea is about ten miles. Both plateaus sink towards the north. The Judean plateau divides into two spurs (separated by a broad structural valley), one ending in Mt. Carmel on the coast, and the other in Mt. Gilboa near the Jordan Valley. Immediately to the north the valley of Jezreel and the plain of Esdraelon form a lowland connecting the Jordan Valley and the Mediterranean. Still further north lies the hilly country about the Sea of Galilee.

The strata are of late Cretaceous age: in the south they are nearly but not quite parallel with the surface of the arches; west of the valley they are practically all limestone: east of the valley nearly all sandstone. Mr. G. S. Blake, the government geologist, considers the limestone and sandstone contemporaneous. The strata rise more steeply than the surface on the western side of the Judean plateau and flatten out on the eastern side, suggesting that a gentle syncline originally separated the anticlines of the two plateaus. The relief shows that the surface of the plateaus is eroded to what Willis calls "matureland," to indicate a state somewhat less advanced than a peneplain. Such a surface must have been developed at a low level. The general geological history of the region now becomes clear: After deposition the late Cretaceous strata were raised above sea level and gently folded into two broad arches bearing some minor flexures and separated by a gentle syncline. Erosion, probably Post-Eocene, then reduced the whole surface to a matureland. Later there was renewed elevation of the arches and depression of the block between them, made possible by the development of great faults, a relation which still remains. The question arises, What were the forces which caused these movements and what was the type of the faults developed? The greater part of the paper is given up to a discussion of this question.

It has been generally assumed that the two great faults that bound the Dead Sea block are vertical or normal faults. Troughs formed in this way have been called "rifts" and are usually (but incorrectly) ascribed to tensions. Willis does not accept this explanation. He describes thrust faults at Mt. Carmel and Mt. Gilboa and finds other indications of compression in the Judean block; he concludes that the movements of the blocks are due to compression. Unfortunately, the main faults are not exposed; landslides and scree cover their outcrops. Willis places the origin of the compressive force under the Mediterranean. He thinks that the Judean block is bounded below by a great horizontal fault, which gradually curves upward to its outcrop at the end of the block. Below and in front of this is a second block, which is of course invisible and which he designates by the letter X. The friction between these two blocks is supposed to melt the rock (which is already near its melting point), and thus the Judean block could easily slide upwards on the fault surface. At the same time the pressure against X forces it downward to form the Dead Sea trough and presses it forward under the Transjordan block, raising the latter. Upcurving faults of this type are called "ramps" by Willis, and the valley between two such ramps is called a "ramp valley." Their existence naturally cannot be determined by observation, and the mechanics of faulting has not been developed sufficiently to show theoretically whether such faults can occur. The mechanics of the movements as given by Willis is too vague and too questionable to make his explanation convincing. This idea makes the elevation of the plateaus and the depression of X contemporaneous; but a study of the physiography of the stream gorges led Willis to the conclusion that the faulting occurred after the elevation of the plateaus. The discrepancy is not elucidated.

The second paper deals with the earthquake. What strikes one most conspicuously is the capricious way the damage was distributed. Three things determine the destructive effect of an earthquake: the intensity of the shock, the nature of the foundation, and the character of the construction. Willis gives an interesting description of building in the country. The poorer natives use mud; the more pretentious buildings have the walls faced with stone, which appears strong but is not; for the stones are cut in rough pyramidal form, the bases being at the surface, and the rest of the wall, perhaps three feet thick, is filled in with mud and rubbish. Where iron floor beams have been used in some modern buildings, they are not tied in but merely rest on the stone; they are easily dislodged and fall, carrying the floor with them. This is what happened to the Winter Palace Hotel at Jericho; and it was completely destroyed. The construction of the newer buildings in Palestine has not improved upon the older methods. It requires no prophet to foretell damage and loss of life in future earthquakes, even though they be not very severe.

The shock was strong at Jerusalem and also at Hebron, twenty miles to the south, though the damage is not reported. This is ascribed to a supposed fault running along the crest of the plateau. The village on the Mount of Olives, ten miles northeast of Jerusalem, was destroyed; a fault has been recognized here. Lydda and Ramle, twenty miles west of Jerusalem on the chalk, were destroyed; whereas Jaffa, ten miles farther on the coast, and indeed all the coast cities were spared. A fault is suggested near Lydda and Ramle. Es Salt and Ammon, thirty miles east of Jerusalem, in Transjordania, suffered severely; this is ascribed to a local fault and a poor location. Nablus, thirty miles north of Jerusalem, was built across a valley. The parts on the hill slopes were not damaged; the part in the valley was destroyed. The foundation there was alluvium and the débris of earlier earthquakes. No comment is necessary. Reine, in the hill country near the Sea of Galilee was destroyed, though no other town in its vicinity suffered damage. The reason is obscure; but it is to be noted that Reine was destroyed by the earthquake of 1837. It was supposed at first that the earthquake originated in the Dead Sea trough, but the shock was not very strong there. The complete destruction of Jericho in this valley seems satisfactorily explained by the fact that it was built on alluvium and by the character of the construction. Willis thinks that the earthquake originated perhaps under the western part of the Judean plateau in a fracture due to compressive forces and that the vibrations were strong enough to cause local faulting at some places where the strains were already near the breaking point.

HARRY FIELDING REID

REPORT OF THE PALESTINE SURVEY COMMISSION

Reports of the Experts Submitted to the Joint Palestine Survey Commission. 741 pp.; maps, ills. Boston, Mass., 1928. 9 x 6 inches.

These reports made on behalf of the Zionist Organization deal with agricultural colonization, labor, and health in Palestine. The Agricultural Colonization Commission under the chairmanship of Dr. Elwood Mead outlines the general problem and makes recommendations. Details of the investigations of the several experts are given in appendixes thus: Economic Data on Jewish Agricultural Colonies in Palestine, by Frank Adams; Soil Reconnoissance, by A. T. Strahorn (compare his paper in this number of the *Geographical Review*); Horticultural Possibilities, by Knowles A. Ryerson; Irrigation and Water Supply, by Cyril Q. Henriques; Education and Research, by J. G. Lipman; the Jewish Settlements, by Sir John Campbell. Sir E. J. Russell contributes a report on his visit to Palestine in April, 1927.

A CITY GEOGRAPHY: MONTREAL

RAYMOND TANGHE. **Géographie humaine de Montréal.** 334 pp.; maps, ills., bibliogr. Librairie d'Action canadienne-française, Ltd., Montreal, 1928. $1.00. 7½ x 5 inches.

We have in this volume an interesting and fresh approach to the study of an urban community. Dr. Tanghe divides the story of the growth of Montreal in two parts. In the first, he considers the physical conditioning factors. In the second, he groups the human. He explains his method at length in the first chapter, which unfortunately is unconvincing. The virtue of the scheme is better demonstrated when he makes the specific application to Montreal, but even here his organization is confusing. Under *position* he includes matters of geographical landscape. Under *situation* he writes of ways of communication, local resources, demographic facts, and matters of economy. The second half of the book deals with commercial analyses, a discussion of house types, which does not seem of great importance, and the internal organization of the city. The author knows his city well, and the book is highly informational.

Yet the volume is disappointing. In spite of the pleasure one has in reviewing the information and the unconventional outline for urban studies, the discussion lacks the restraint which should mark a scientific thesis. One of the most interesting portions discusses the St. Lawrence waterway. The author sees, with the completion of the canals, traffic passing by the doors of Montreal as it now passes Quebec. Yet in the same breath he challenges the economics by which men argue that the lake cities may become seaports. He brands arguments which he opposes as ridiculous. In places the text takes on the nature of a philippic rather than an analysis. He scores a point when he says that Canada has little need of expensive construction of power development in the St. Lawrence when there is so much easily obtained power from the smaller streams to the north. Perhaps it is natural that he sees the question of the future of the St. Lawrence from a purely local point of view. As such, it is important. The book is nevertheless worth while, for it abounds in facts; and the opinions, acceptable or not, represent a point of view of the people of a great city who will be affected more than those of any other city by commerce and energy development from the St. Lawrence project.

Roderick Peattie

A Geographical Study of Finland

Eugene Van Cleef. **Finland—the Republic Farthest North: The Response of Finnish Life to Its Geographic Environment.** xv and 220 pp.; maps, diagrs., ills., bibliogr., index. The Ohio State University Press, Columbus, 1929. $2.50. 9 x 6 inches.

Mr. Van Cleef's little book, informed throughout with a friendly and sympathetic spirit, gives a well balanced picture of Finland. While the arrangement is more or less conventional the treatment is fresh, and encyclopedism is happily avoided by the selection of salient geographical facts. Thus the future of agriculture is discussed as regards "the national policy of forest conservation, the utilization of peat bogs, and the possible adaptation of crops to the environment"; in the chapter on climate the danger of frost, "the most disheartening obstacle with which Finnish life must contend," is stressed, methods of clearing to permit free air drainage are described, and tables of frost penetration are given. The overwhelming importance of the forest stands out. Over 73 per cent of the area of Finland is forest-covered; one-fifth of the total population is dependent on the wood-products industries; 85 per cent of the buildings in Finland are wood, and five per cent are timber in combination with brick or stone. An entire chapter is devoted to the coöperative societies that have had a marked success in promoting rural welfare. Under "seafaring activities" the ice problem of the Baltic and the creation of the free port of Hanko are noted.

Speaking of the settlement of the country, Mr. Van Cleef observes that the Finns did not at first occupy the areas of best soil and that psychological and traditional factors, if they may be so termed, still play no little part in guiding Finnish settlement both in Finland and in America. Prior to his visits to Finland (1923 and 1926) Mr. Van Cleef had studied "the Finn in America" (compare his paper of this title in the *Geogr. Rev.* Vol. 6, 1918, pp. 185–214), and he concludes his book with a chapter under the title "Emigration—the Finn in America."

The useful bibliography is prefaced by the note that much of the literature issuing from the country is propagandist in character but yet is distinguished by a high regard for the truth. Much of this literature, too, is by authorities of distinction. An instance in point is the Otava Publishing Company's "Finland—The Country, Its People, and Institutions" (Helsingfors, 1926) in which chapters on the geology are contributed by J. J. Sederholm (the ancient rocks) and M. Sauramo (the superficial deposits).

In addition to photographs there are many well conceived maps and diagrams, though some of the maps suffer from the small scale of the reproduction. A clear general map (1:2,000,000) supplied by the Government of Finland is an excellent feature.

A Norwegian Plant Preserve

Rolf Nordhagen. **Die Vegetation und Flora des Sylenegebietes. I: Die Vegetation.** ix and 612 pp.; map, diagrs., ills., bibliogr. *Norske Videnskaps-Akad. i Oslo, Skrifter*, 1927, *Mat.-Naturv. Kl.*, Vol. 1, Oslo, 1928.

The Sylene region is in Norway, adjacent to the Swedish border, and a few miles south of the transpeninsular railway route from Sweden to Trondhjem. It was created a plant preserve in 1917.

The region is essentially a rolling upland, dominated by low rounded hills or small mountains, the range of altitude being from 720 meters (2300 feet) to 1700 meters (5600 feet). Lakes and marshes abound, and there are numerous irregularly disposed rivers and smaller streams. In short, the landscape everywhere bears evidence of glacial activity both of a local nature and in the form of ice sheets. Extensive boulder-strewn plains are bordered by splendidly developed alluvial terraces possibly representing the deposits of marginal lakes.

The scanty vegetation permits vast exposures of bed rock. The geology proper, however, is only briefly touched upon in the volume before us. More attention is given to the soil profiles and the effect of solifluction. The climate is relatively mild, the temperatures ranging from 18 above zero Fahrenheit during the winter to 52 during summer. The rainfall is moderate, averaging less than 25 inches a year.

The vegetation, which is of a decidedly arctic-alpine nature, is treated in detail under a subdivision into five major groups: birch woods; thickets of willows, dwarf birch, and juniper; dwarf shrub associations; grass and herb associations; and aquatic associations. A final section considers the distribution of the vegetation by subalpine and alpine regions.

A. K. Lobeck and N. C. Fassett

A General Work on Aerial Photography

Clarence Winchester and F. L. Wills. **Aerial Photography: A Comprehensive Survey of Its Practice and Development.** Foreword by Sir Alan J. Cobham; introductory notes by Sir Peter Clutterbuck and Sir Felix J. C. Pole. xvi and 236 pp.; diagrs., ills., index. American Photographic Publishing Co., Boston. $10. 10 x 7½ inches.

Aerial photography is a new science and an infant industry. As is usual in such cases, the literature on the subject is confined for the most part to highly technical papers or papers of a controversial nature which, though both essential and interesting to the expert, do not help the uninitiated student or the layman. Consequently a book in English which deals with the whole subject in a more or less popular manner is to be welcomed.

Though many of the chapters are interesting by themselves, the book as a whole is extremely uneven. Too much space is devoted in the beginning to photographic technique, most of which can be gleaned from any up-to-date textbook on photography. For instance, at the beginning of the chapter on lenses the authors say, "The general principles of optics as applied to lenses used in photography from the air do not in any way differ from the principles generally applied to lenses for terrestrial photography;" and yet seven pages are devoted to this subject. Later on in the book the chapter on "Geographical Application" is less than two pages long.

In Part III the authors have made the mistake of giving brief specifications of numerous apparatus on the market without any attempt at a critical analysis and yet without emphasizing that their survey is incomplete.

The sequence of certain chapters seems illogical, especially as regards the subject of aerial surveying. Chapter 12 is on map plotting, contouring, and rectifying apparatus, Chapter 13 on aerial cinematography, Chapter 14 on stereoscopic photography; but not until Chapter 19 do we get anything like a general account of the practical problem of aerial surveying. Much of the most useful material about aerial surveying is contained in Chapter 20, "Aerial Photography Abroad."

Attention should be drawn to the statement (p. 231) that "the greatest scope is to be found in unmapped regions where the camera can cover vast and valuable areas not easily accessible to ground survey or exploration parties. Undoubtedly it is in this direction that aerial photography has the greatest opportunity for practical development."

Without wishing to detract from the great importance of aerial photography in reconnaissance survey, it should be pointed out that this statement has not been in any way proved and is misleading in that it gives the impression that aerial surveying is only a substitute for ground surveys. It is much more likely that aerial photography will be found valuable for the reason that aerial surveying *combined* with a discriminating use of accurate ground control will eventually become the best and most economical method of surveying for all purposes and especially in highly developed regions.

In spite of these serious defects the book is useful in that it is bound to stimulate general interest in the subject. It is excellently produced, with remarkable illustrations.

CORRESPONDENCE

Dr. H. H. Clayton has sent the editor of the *Geographical Review* the following memorandum received by him from Dr. A. E. Douglass. It refers to Dr. Clayton's discussion of Dr. Douglass's report on the cyclograph at the Second Conference on Cycles (see *Geogr. Rev.*, Vol. 19, 1929, pp. 296–306).

"Just a memorandum regarding a sentence in the *Geographical Review* report of the Second Cycle Conference, page 298. It refers to your discussion after I had said something about the cyclograph to the effect that the various cycle methods of analysis, including the cyclograph, assumed constancy of phase. I wish to note here that one of the marked advantages of the cyclograph is that it does not assume constancy of phase, and change of phase is as apparent at once as change in length of cycle. If I remember rightly at the time of that discussion, after you had referred to this change of phase, I remarked that I had observed such changes also and, of course, I should have said at that time that they are as apparent as the cycle itself.

"But your remarks about the change in phase have helped me to take such changes more seriously. I have observed cases, as in the California big trees, where I could not get away from the change in phase, but yet it always made me feel a little uncertain, and I have left out some important references in some places on that account. I believe I have hesitated to put in print anything about change in phase; but there is a reference to it in Volume 1 of "Climatic Cycles and Tree Growth," page 102, middle paragraph, where the sunspot cycles show a reversal of phase between the early part and the late part of my 500 year tree records. I have never published some very striking phase changes in Sequoia records but in time I will get at them."

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